THE

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THE LONDON OVERHEAD WIRES ACT.

WHEN the proposed London County Council bye-laws for the regulation of overhead wires were published at the latter end of last year, we expressed the hope that electrical engineers and others interested in the erection and use of such lines would at once take them into consideration, so as to determine what objections, if any, should be raised to the various clauses when they came before the Board of Trade for approval; and we now publish in our present issue a copy of a petition which is being presented to the Board of Trade by the London Chamber of Commerce, and which sets forth the objections raised by the Electrical Trade Section of the Chamber. In this petition frequent reference is made to the bye-laws recently passed by the Board of Trade for the regulation of overhead wires in the provinces, and many of the clauses in the proposed London bye-laws are objected to on the ground that they differ from the provincial ones in such a manner as to hamper the development of the industry, and that these differences are quite unnecessary, as the provincial bye-laws are, the petitioners consider, quite stringent enough to adequately safeguard the public interests.

Of the clauses which deal with the erection of overhead lines from the point of view of public safety, the most important is certainly that which prescribes the factor of safety, and the wind pressure, which must be allowed for; and we sincerely hope that the Chamber of Commerce will be successful in their efforts to modify it, as all previous practice has shown it to be needlessly stringent, and its enforcement would, as mentioned in the petition, necessitate the removal of all existing wires, and thereby inflict a most serious blow on the industry. In close connection with this clause are those which provide for the proper maintenance of the lines, and for access for purposes of inspection, and in this matter we cannot help thinking that it would be better for the Chamber of Commerce to try and arrange for periodical inspection, rather than to continue the line of action adopted in the petition. It would, of course, be necessary to have some guarantee that the County Council should employ properly qualified engineers for the purpose; but, if that could be ensured, considerable advantage might be derived from inspection, as the maintenance of the lines in good condition is the most important point of all, and, therefore, if facilities could be offered for inspection, there would be a much stronger case in favour of reducing the requirements as to the initial strength of the lines.

The objections raised to clauses 5 and 12, which deal with the length of span and the maximum diameter and weight of cables, are, we consider, well founded; and the clauses might well be modified, since the safety of the lines can be equally ensured by working to the same specification as regards wind pressure and factors of safety, whatever may be the size and weight of cable, or the length of span; and there is no doubt

that the restrictions which are sought to be imposed in these clauses would prove very irksome in many cases. When we come, however, to the clause which deals with the angle at which the wires shall cross a street, we do not find ourselves in agreement with the petitioners; indeed, we consider it would be to the advantage of the telephone companies to accept it, as there is no doubt that their wires are less unsightly the nearer they approach to making an angle of 90° with the street; and, further, as a smaller amount of wire is then seen overhanging the street, we believe that the companies would be able to erect a far larger number of wires before the objections on the score of disfigurement became so pronounced as to lead to the prohibition of any further increase in the number of overhead wires.

With regard to the clauses which relate to plans and notices, there can be no doubt that they would prove irksome as they now stand, and we would suggest that a compromise might be made as in the case of electric lighting notices, that is to say, a saving clause might be inserted which would cover cases of emergency, and the County Council might accept a much shorter notice for alterations or additions to subscribers' wires, in the same way that they now accept a four days' notice with respect to the laying of service wires by the electric supply companies; and with these modifications, and an extension of the time allowed for the delivery of the plans and particulars of existing lines, we do not think there should be much difficulty in working to these clauses.

A METHOD OF COMPARING THE DEGREES OF VACUUM IN INCANDESCENT LAMPS.

IN an article in the *Electrotechnische Zeitschrift*, M. Boccali describes a method of comparing the degrees of vacuum of different incandescent lamps by measuring the energy which must be expended on the carbon filament to maintain a fixed difference of temperature between it and a bath of oil in which the lamp is immersed. The method is based on the fact that the temperature, and therefore the resistance, of any conductor through which a current is passing depends not only on the nature and size of the conductor, but also on the surrounding medium; and, as an example of the influence of this latter, two curves are given which show the relation between the resistance of a carbon filament and the current passing through it, first when the bulb of the lamp is exhausted, and then when it is filled with air at ordinary pressure; these curves showing that a far larger current is required through the filament to bring about the same decrease of resistance if the bulb contains air than if it is exhausted. The method employed for comparing the degrees of vacuum is as follows:—A Wheatstone bridge is used of which the lamp to be tested forms one leg, and the resistance of the filament is first balanced when the lamp is immersed in a bath of oil, the temperature of which is maintained constant at 50° Cent. The temperature of the oil bath is then reduced to 20° Cent., and the current through the bridge is increased until that part of it which flows through the lamp is sufficient to raise the temperature of the filament to 50°, or, in other words, to decrease its resistance so that a balance of the bridge is once more obtained, at which time the current through the lamp is measured. M. Boccali found that lamps of the same type and manufacture gave very different results, the tests showing that the energy required to raise the temperature of the filament to 50° was nearly twice as much in some cases as in others, and he considers that the different degrees of vacuum are responsible for these variations. It would have been interesting if the results of tests giving the efficiency of the several lamps in watts per candle under the normal working conditions had been added to the article, so that an estimate might have been made of the practical effect of these variations in the degrees of vacuum, as we believe that any deductions as to the efficiencies of the lamps made from tests at very low temperatures would be extremely misleading, and that it would be found that as the temperature of the filaments was increased, the difference between the currents required to maintain the temperature would decrease very rapidly, and the lamps become much more nearly equal in behaviour.

LOAD FACTORS.

SINCE the reading of Mr. Crompton's paper on "The Cost of the Generation and Distribution of Electrical Energy," in the course of which he proposed the use of the term "load factor," the expression has been applied to many different ratios, with the result that it is not always easy to understand which of the various ratios is being referred to. Mr. Crompton himself gave two definitions of it in the early part of his paper, viz., the ratio of the actual output of any plant to the output it would give if it were worked continuously, day and night, at its full load; or, as an alternative, the ratio of the total area of the load diagrams during any given period to the area of a rectangle contained between the base line and a line drawn parallel to it through the point of maximum load observed at any time during the year. This second definition substitutes, in the denominator of the ratio, the maximum observed output of the plant for the maximum possible output of the plant, and the value of the load factors obtained may therefore vary considerably, unless the generating plant is divided up into a number of units, or the plant, exclusive of the necessary reserve, is so proportioned as to be fully loaded at the time of maximum output.

Reference is also made at times to daily and monthly load factors, and it is not always clear whether the value of the denominator is based on the maximum output at any time during the year, as is suggested by Mr. Crompton's definition, or on the maximum output observed during the particular period under consideration. The term load factor has also been applied to other ratios than those named above, as, for instance, in the paper recently read before the Institution of Electrical Engineers by Messrs. Heaviside and Jackson, the ratio represented by it was that of the actual output during the year, to the output which would have been required if all the lamps wired had been burning continuously, and although in this paper the authors were careful to explain fully the meaning they attached to the

expression, it is, we believe, frequently used without any such explanation.

As a further example Mr. Frank Bailey, in an article on "Central Station Load Factors," which appeared recently in our contemporary, *Lightning*, enumerates three load factors, viz., a total plant load factor, or ratio of actual output to the output of the plant if run continuously at full load; an engine load factor, or ratio of actual output to the total possible output of the engines required; and a lamp or supply factor, or ratio of the number of lamps supplied at one time to the number of lamps connected. These three factors are illustrated by a load diagram in which the following values are given for them:—The plant load factor for the year is 9·7 per cent., the engine load factor in January is 81 per cent., and in August 62 per cent., and the lamp factor varies from 39 per cent. in January to 19 per cent in August. Besides this diagram two others are given, showing the effect of various plant load factors on the works cost per unit delivered, and on the balance sheet, but although they show very clearly the manner in which the load factor affects the cost of production and possible revenue, we fear that, if taken too literally, they will present matters in a too roseate hue to the town councillors and others for whose benefit we understand the article is intended, as the works' costs appear to us to be figured out on a more economical basis than is justified by the returns of any of the existing companies.

Reverting, however, to the term load factor, we have said enough to show that this most useful expression is likely to be the means of misleading people to a great extent, unless a general agreement is come to for restricting its use, when not qualified by explanatory adjectives, to one particular ratio; and we would suggest, therefore, that it should only be used in the sense of the first definition given to it by Mr. Crompton, and that whenever it is desired to express any other of the ratios to which the term might be applied, care should be taken to state fully the particular factor which is referred to.

Sparking and Flashing of Dynamos.

UNDER this title a paper was read by Mr. F. R. M'Berty before the Chicago Electrical Association. The writer, after discussing the sparking difficulties at great length, proposes with ring windings to use two brushes connected to each holder in such a manner, that one has an angular lead of about the width of a commutator segment. By this means a coil will always be short-circuited beneath the brushes. Surely Mr. M'Berty must be aware that the same end is attained more easily by brushes sufficiently wide to bridge over about one and-a-half segments. This is a matter of every day practice in low tension dynamos, and there is no trouble with sparking. In high tension dynamos of the ring type, the same result can be obtained if the coils be sufficiently numerous to reduce the self-induction of a single coil to the proper limits. Practically, however, this does not pay, owing to mechanical difficulties in the construction of the commutator, and further the short-circuiting of the coils tends to heat the armature, and so the brushes are made narrow, about the width of a segment, and the sparking is reduced by a large forward lead. The current, in fact, is commutated in that part of the field where the magnetic induction tends to cause not only an equal and opposite current to that due to the self-induction of the coil, but also an E.M.F. sufficient to start the main current in the required direction.

Transformer Magnetisation Curves.

MESSRS. MOORE AND LINGLEY have recently investigated the form of the magnetisation curve in iron when the frequency is about 140 ∿ per second. The method employed was to determine the form of the primary and secondary current curves and the secondary E.M.F. curve, and from this to get the form of the magnetisation curve. This is easily plotted from the observed curves, for the E.M.F. curve integrated gives the induction, and the magnetising force can be got by plotting the resultant ampère-turn curve from the primary and secondary ones. The curves shown seem to prove that the process of magnetisation is essentially the same at this frequency as with ordinary slow magnetising cycles, although the shape is somewhat different. This proves that the loss per cycle is roughly the same at this periodicity as with ordinary processes, but the authors do not seem to have yet gone into the vexed question of the varying loss with varying load. Judging from the curves given, the loss in the Westinghouse transformer they tested was about a normal iron loss when the transformer was loaded to 75 per cent. of its full output. The method of getting the initial curves was that of Dr. Louis Duncan; it consists in passing the current, whose form is to be investigated, round one coil of a dynamometer, and passing an instantaneous one of known value round the other coil, then at any required point of the cycle the deflection on the dynamometer is proportional to the instantaneous value of the variable current or E.M.F. at that particular point of the cycle.

Transformer Design.

THE second, and last, of M. Dobrowolsky's papers has appeared, and contains some interesting matter. He is of opinion that self-regulation is altogether a secondary consideration, on account of the existing supply losses, and by allowing a 5 per cent. loss at full load in the copper circuits, he shows an all day efficiency (on paper) that is quite as good as the Hedgehog form shows (also on paper). Outside these points there is little novel in the communication.

Calculation of Conductors.

IN the absence of a well drawn up wiring table, there is sometimes a good deal of labour involved in calculating out leads for supply purposes, and Mr. Fay, in the New York *Electrical Engineer*, gives a short and convenient little table for calculating them logarithmically; to those engaged in this work the formulæ given by him should prove useful.

Azores Cables.

IT is anticipated that the manufacture of these cables will be commenced immediately at the Calais works of the French Telephone Company, and that the laying will be undertaken before the month of October next, which date is much in advance of the 1st of April, the period fixed in the contract with the Portuguese Government for the completion of the enterprise. In Lisbon it is intended to establish a school for the education of the employés of Portuguese nationality, who are to carry on the service of these new cables as is prescribed in the contract. The system of signalling to be employed will be a choice from three kinds, which up to the present are completely unknown to the Portuguese telegraph service. As the dispatches will mostly be in the Portuguese language the employment of native clerks presents many advantages.

A GENERAL RELATION OF ELECTROMOTIVE FORCE TO EQUIVALENT VOLUME AND MOLECULAR VELOCITY OF SUBSTANCES.

(*Concluded from page* 756.)

GENERAL REMARKS ON DR. GORE'S RESEARCH.

THE general truth that any circumstance which separates the molecules of a substance further asunder, without producing chemical change, usually increases the E.M.F. of the substance, evidently includes gases; for we know that when a gas or vapour is forcibly rarefied by exhaustion, the residuary portion of it is chilled, absorbs heat, and the remaining molecules, therefore, must possess greater freedom and velocity of motion than they did previous to rarefaction. The statement agrees with the well-known fact that oxygen, when expanded by rarefaction, or when diluted by nitrogen (an inert gas), unite more energetically with phosphorus, notwithstanding the diluting effect of the nitrogen; and it is probable that if such cases of chemical union could be examined in a similar manner to the cases of the voltaic action investigated by Dr. Gore, *i.e.*, if the degree of chemical energy of each of the substances were measured, and the *mean* calculated, the actual chemical energy of union of the substances would be similarly found to increase by dilution and rarefaction. Further, in a special experiment, Dr. Gore found that by dissolving one volume of bromine vapour in one volume of water, and diluting the solution to 1,000 vols., there was a gain of mean E.M.F. of 21·8 per cent., with a Zn + Pt couple.

The probable reasons why so extensive a generalisation as that of universal increase of volta-E.M.F. with molecular distance has been overlooked, are:

1. Because of its being disguised by the circumstance that when a solution of an acid or salt is diluted with water, the simple E.M.F. of the mixture is very often smaller than that of the less diluted substance.

2. Because the *mean* E.M.F. has usually not to be considered, and no correction has been made for the E.M.F. of the water.

The changes of *simple* E.M.F. of the *mixtures* have been studied, but the *mean* E.M.F. of the *ingredients*, and the *actual* ones of the *individual constituents*, have been largely omitted. As out of 108 instances of solutions of electrolytes in Sections A and B of this research, 86 gave *losses* of *simple* E.M.F. by dilution; and out of 105 cases of liquefaction and dilution of metals by mercury in Sections C and D, 64 gave *losses* of such force, it is evident that neither of those classes of mixture would it be correct to say that the simple E.M.F. "always increases by dilution." (*Vide Chem. News*, li., p. 292 and lii., p. 5). For curves representing the variations of simple E.M.F. caused by a series of dilutions of mixture, *vide Phil. Mag.*, May—December, 1890.

It might be supposed, as dilution of the positive metal or of the electrolyte diminishes the number of molecules of each of those substances which at any given moment strike each other per unit of surface, that this would *diminish* the actual E.M.F. of the diluted substance; but it was found that, although by diluting a solution of bromine to nearly 300 times its bulk, the simple E.M.F. of the solution was decreased from 1·98 to 1·61 volt, the *mean* of that of the bromine and water was augmented, and therefore the *actual* E.M.F. of the bromine alone was *increased*. It is well known that enlarging the positive plate of a voltaic cell, and thereby increasing the number of its collisions with the negative substance, does not much affect its E.M.F. It is not the number of molecular collisions, therefore, but the *velocity of molecular motion*, which most affects the E.M.F.

The water of dilution added to an electrolyte affected the mean E.M.F. in two opposite ways, viz.:

(*a*) By simply diluting a solution of greater energy than itself, it usually produced a mixture having less E.M.F. than the original one.

(*b*) By enlarging the volume and thus permitting greater freedom and velocity of motion, it increased the *actual* E.M.F. of the dissolved substance, and the *mean* of that of the mixture; and in many cases the simple E.M.F. of the mixture was even greater after dilution than previous to it.

As no sign of increased E.M.F. of the water was observed in any case, and as the bulk of the active substance to that of the water was small, its dilution effect in increasing the E.M.F. of the water must also have been small.

THEORETICAL CONSIDERATIONS.

The results in general agree with the view that in cases of pure dilution, the molecules of the active substance are simply separated further apart without their directions of movement being changed or their motions neutralised; but that in proportion as the added or diluting substances chemically unite with the diluted ones, the directions of movement of the molecules of each are altered, the molecules aggregate into groups, more or less of their motion is neutralised, heat is usually evolved, contraction of total volume frequently occurs, freedom of molecular motion and the mean amount of E.M.F. are nearly always largely diminished, and these changes, and the coincident ones of other properties which simultaneously occur, differ with every different substance. The fact that even a neutral salt excites E.M.F. indicates that during its formation a portion only of the molecular motion of each of its ingredients is neutralised.

A large number of the results of Dr. Gore's investigation, especially those for dilution of acids and salts, appear to agree with the theory of dissociation, because the most energetic substances usually yield the greatest gains of E.M.F. by dilution. But since this theory, in order to include the whole of the results, would require not only the dissociation of compound substances, but also that of the halogen elements by simple dilution with water, and the whole of the simple metals by dilution with mercury, and even with solid metals. Dr. Gore has preferred to employ the simple explanation of increase of volume and of molecular distance and velocity as including the cause of increased volta E.M.F. and current. Moreover, as dissociation is not energy, it cannot be the cause of electromotive force or current.

Nearly all cases of chemical action agree with the theory that the molecules of all substances are in a ceaseless state of motion, and that chemical union and chemical heat are due to neutralisation of opposite molecular movements of the uniting bodies; similarly, all the results of this research compel us to adopt a mechanical explanation of voltaic action. The circumstance that an increase of freedom and velocity of molecular motion of *either* of the uniting substances by dilution is itself sufficient to augment the *mean* E.M.F. and chemical energy of *both*, is conspicuously similar to the augmented violence of collision and amount of heat evolved by two colliding solid bodies when the velocity of only one of them is increased. As it is evident that dilution cannot add to the mass or weight of the active molecules, it can only add to their exciting power by altering their direction or increasing their velocity of motion; and as energy cannot be created, the increased velocity is probably due to absorbed heat. The latter statement is supported by many well-known facts. In the case of strong acids and alkalies, where heat is *evolved* and the E.M.F. simultaneously *increased* by dilution, it is probable that a portion of the heat set free by contraction of the total volume is reabsorbed to satisfy the increased molecular velocity.

According to these views the essential cause of voltaic action in opposite molecular movements of the positive metal and the negative constituent of the electrolyte, and the necessary condition of conversion of such motion into volta E.M.F. and current, and the attendant chemical action is incompatibility of molecular motion of the two uniting substances; the existence of E.M.F. appears to chiefly depend upon relative direction of the molecular motions, and its degree upon the velocity of the oppositely moving particles, and dilution probably increases the velocity of the whole of the molecular motions of a substance, but only a portion of these motions is converted into current. Increase of volta E.M.F. may therefore be due to increased velocity of the oppositely moving molecules of the two uniting substances.

These views are further supported by the well-known facts that the substances which produce the greatest voltaic and chemical energy, are usually those elementary bodies which possess the most opposite essential properties, and that after their chemical union, a portion of energy of chemical union still remains. The phenomena, however, as Dr. Gore says,

are much more complex than these simple ideas indicate; and each degree of electromotive force is probably a result of a concrete collection of simultaneous mechanical impulses of the molecules, each having a different amplitude of motion.

A WHALE KILLED BY ELECTRICITY IN THE YEAR 1852.

BY A. M. TANNER.

IT appears from a French patent, granted August 7th, 1852, to Dr. Albert Sonnenberg, of Bremen, Germany, that the magneto-electric machine and accessories, forming the subject matter of said patent, had actually been used for killing a whale. This must indeed be considered a remarkable achievement at such an early date in the history of the magneto-electric machine, or more properly, the dynamo-electric machine, if we accept the generic definition of Profs. Thomson and Houston that all machines for producing electric currents by mechanical force are dynamo-electric machines. It is not necessary to enter into details as to the construction of Dr. Sonnenburg's machine. It is sufficient to state that it consists of a crown or ring armed with a number of armature or induced coils turning before a number of permanent field magnets, with a current collecting ring and brushes, so arranged as to be capable of giving "a whale 720 galvanic shocks in one minute."

The accessories used in connection with the current generator are an ordinary harpoon carrying an electrical conducting wire, covered by the harpoon line and connected with one pole of the generator, so as to form one half of the electric circuit, the other half being formed by the metal-plated bottom of the boat containing the magneto machine and the sea water.

When the harpoon is lanced into the whale the circuit is completed, and as stated in the description, the "electric fluid passes through the body of the whale, and the latter receives at each rotation of the machine 12 heavy shocks, and as the machine can make one turn per second, the whale will receive 720 shocks per minute, of such a force as to stun or render the whale unconscious, as has been *proven* by *electrical experiment*."

It is a difficult matter to refute the Bremen doctor's underscored statement that he had actually been able to make a whale unconscious (*aneantit la baleine*, in French description) by electric shocks from his machine, and so the writer must believe the "whale story" with the mental reservation, however, that the whale must have been a little one. Bremen being so near the North Sea, it suggests the idea that the electrically-killed whale of the Bremen doctor might have been the one of Olivette renown. The song here goes :—

In the North Sea lived a whale,
Who bobbed up serenely from below,
&c., &c.

It is needless to say that when the Olivette whale learned of the fate of his mate he ceased "bobbing up serenely," and went to more congenial waters near the North Pole, where the "demon electricity" cannot follow him.

ELECTRICITY AT THE CORONATION JUBILEE AT BUDAPEST.

[FROM OUR OWN CORRESPONDENT.]

ON the 25th anniversary of the coronation of his Majesty the King of Hungary, June 6th, 7th and 8th were especial festive days for the Hungarian nation, and were celebrated with equal enthusiasm and splendour. In the magnificent illuminations of June 7th, electricity took a prominent part, the more striking, as there appeared an interesting competition between gas and electricity.

The gas company, as well as the electric installers, had been for weeks zealously engaged in preparations for the contest. The electric light was characterised by the mass of arc lamps and the intensity of illumination, whilst the gas light aimed at an especial effect by the variety of forms and by adapting the lines of colours to the architecture of the buildings. In this illumination, along with the firms Siemens and Egger, of Vienna, Ganz & Co., took a part corresponding to their position, as the sole Hungarian electro-technical works. The transformer system was made conspicuous by the last-mentioned firm, as they illuminated the royal castle by means of a temporary connection.

The Andrassy Street was rich in illuminative effects, beginning at the Triumphal Arch, which in the light of nine arc lamps presented a much more pleasing spectacle than by day, and extending to the mighty projector at the end of the Avenue. In spite of the rain a crowd of many thousands surged on the broad footways, and even on the carriage-way, now and then occasioning very unpleasant blocks and collisions. A splendid aspect was presented by the Saxlehner Mansion at the beginning of the street, with its three arc lamps. Further on, were many transparencies with the portraits of the King and the Queen, with the inscriptions in letters of flame : "Eljen a király" (Long live the King.)

Truly imposing was the illumination of the Royal Hungarian Opera, its five terrace niches displaying the initials of their majesties, the Hungarian crown and two stars, surmounted by a gigantic sun. The Café Reuter, opposite the Opera House, was distinguished by a many-coloured sea of stars.

In the Theresian ring the various effects were eclipsed by the richly illuminated triumphal arch and the splendidly lighted Western Railway Terminus. Its front was shown by 50 arc lamps, reflected in the glass walls. The honour of the Waizner Boulevard was saved by the colossal projector of Haggenmacher's Mill.

Many private houses of the Leopold Stadt displayed not merely a rich show of light in the windows, but on the balconies and mouldings. Perhaps the most effective object was the luminous fountain, opposite the Reformed Church. It was tastefully illuminated with coloured glow lamps from the mighty lower basin up to the "Danubius" (a colossal statue personifying the river Danube). The effect was magical. The drops of water as they fell into the basin became a shower of emeralds and rubies.

Further must be mentioned the National Theatre, the National Casino, with the Hungarian Arms composed of 400 coloured glow lamps; the Hotel Pannonia, the People's Theatre, and the Central Passenger Railway Station.

The view from the Citadel and the Royal Castle fascinated all who succeeded in forcing their way through the dense crowd amidst rain and mud. The arc lights playing on the raindrops produced the effect of numerous rainbows.

Showers of rockets were, at the same time, sent up from the Blocksberg, the suspension bridge, and from three ironclads at anchor in the Danube. Not until midnight did the public cease crowding to the Danube quays.

THE ECONOMY OF CONDENSING ENGINES OVER-RATED.

BY W. H. BOOTH.

THUS argues Mr. Babcock in your New York contemporary, the *Electrical Engineer*. The peg on which he hangs his argument is the fact that the exhaust steam from some electric light stations has been sold for heating purposes eight months in the year, and he might have added that during the four months when it cannot be sold there is less of it being made, though the short summer days of the United States do not, as compared with their comparatively long winter days, so far lessen the demand for light below the maximum, as is the case in England, where in winter it is dark at 4 p.m., and in summer the domestic consumer at the latter end of June needs no light at all, at least, in the North of England, beyond the Mersey.

To run non-condensing for 12 months for the sake of selling exhaust during eight months implies, roughly, throwing away a fourth of the fuel in order to sell two-thirds of a fourth. It is losing three-twelfths and getting back two-twelfths, a net loss of a twelfth the year

round. This would imply selling during eight months the exhaust steam for a sum which would pay for the coal otherwise wasted in twelve months. A station using, when condensing, 300 tons per month, must buy, say, another 100 tons every month, and sell the price of 150 tons each month in the cold eight months. There is no pretence to accuracy in the above figures. Actual practice might give worse or better results, but it is tolerably certain that where steam is sold, and is required to be passed through any length of pipe, there will be a good deal of back pressure on the engine pistons, or there will be very little go in the steam at the terminal points.

Mr. Babcock uses a tricky method of figures when he speaks of condensing being only able to save 3 per cent. of the heat units of the fuel. In the first place, very many boilers throw away half the heat units, and the steam, as it goes to the engine, only takes with it the other half. At most, then, the engine is to be debited with 50 per cent., and if it uses 10 per cent. of the total units it will use 20 per cent. of what is offered to it, so that if the engine efficiency be increased 25 to 33 per cent., as Mr. Babcock allows for condensing, with increase from 10 to 13 per cent. of the total units used, there would be actually used by the engine, 26 per cent. of the heat offered it instead of 10 per cent., as Mr. Babcock makes it appear, and the heat rejected at the condenser will be but 37 per cent. of what the engine draws from the boiler, a very different thing from the 80 per cent. Mr. Babcock tries to show, and one which in his 100 H.P. of boilers would give a value to the exhaust steam, if his figures be so far correct, of $1,380 to $2,310, and not the $3,000 to $5,000, which he finds. Certainly there ought to be every consideration given to the question of condensing when designing an installation, for much may be done for economy, if the subject be handled properly.

Often, perhaps generally, it will be found that exhaust steam can best be sold where there are the least facilities for condensing, and where ground values are perhaps such as to demand non-condensing engines. At the same time, even if space be saved by non-condensing engines more space is needed for the boilers, and as a rule the space saved in engine dimensions is less than the necessary increase of the boilers. Electrical stations are far too frequently made servile copies of some other station, and the steam engineering of some places, arranged by architects—and how many are left to the mercy of these gentlemen!—is such that economy of any sort is impossible. It is not unknown where condensing water has been freely available, and where there has been a direct sale for the exhaust steam where the engines have been made non-condensing, and the exhaust steam has been blown into the air and live steam from the boilers furnished for heating purposes.

While there is a great back pressure from forcing exhaust steam through pipes, there is a method of using and selling the heat which has not yet been attempted. This is to heat water by the steam, which can be done with very little addition to back pressure, and send the water round in the pipes to consumers. There are more people who would buy hot water than would buy steam. The water would flow to consumers without any more expense of energy than it is now given to flow to them cold. The cooling of the exhaust steam could be made perfect by the system of counter currents, and a magnificent vacuum could be obtained without anything paid for condensing water. The water company would supply consumers on a water rate, as at present, charging so much per 1,000 gallons for all hot water, which would go *via* a meter. The cost of the hot water pipe would be less than the cost of a steam pipe carrying atmospheric steam, and the heat lost by radiation from water pipes at, say, 130°, would be less than from bulky steam pipes at 212°.

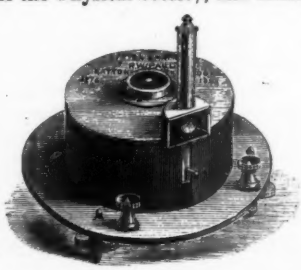
Domestic purposes do not require water very hot, and after passing round and heating a large building, the water could still be useful in a house. There are thousands of houses in London where, during the summer, no fires would be lighted if it were not to heat the bath water, whilst many who look at the cost of gas to heat water to 212° from normal, would save half the cost of gas if they could start with water at 130°, and this temperature would mean a good vacuum at the engines. Mr. Babcock was never more wrong than when he came to argue that the economy of condensing was overrated, and he made matters worse when he used misleading arithmetic to help him out, and overlooked the fact that condensation and the use of exhaust heat are not opposing factors, but concurrent economies. Even if a domestic consumption could not take all the hot water produced, there would be many demands for it as a hot feed to steam boilers.

In fact, given a demand for the water, there need be no fuel heat rejected after the steam has left the boiler, and instead of deliberating whether to condense or not, a rational system would utilise the waste heat, if this could be done, and would use the heating apparatus as the means of condensing. Probably the real crux of the question would come in determining whether it would be better to sell water at 130° and have a good vacuum, or sell it at 150° and have a poor vacuum, or condense with a heater delivering 130° water and use live steam, or an "economiser" feed water placed in the boiler main flue to add more heat to the water, if not so readily saleable unless above 130° temperature. One advantage of selling hot water instead of steam would be the chance of using a flue heat "economiser" to save some of the heat units now going to the chimney, and the hot water system would also, even if not much drawn upon during the summer months, afford in the earth a lengthy circuit round which condensing water could be circulated, so that the economy of condensing need not be sacrificed in summer as well as the exhaust heat. When the sense of this comes to be appreciated, rival companies with given areas to light will be found swapping condensing water when it cannot all be sold.

To turn Mr. Babcock's words against himself with a little italicised transposition, we may say: "In cases where *exhaust steam is* used, this is given as the reason why *condensing engines are* not called for. In the mind of Mr. Babcock the fact that *exhaust steam can be sold* closes the case—but does it?"

PROF. AYRTON AND MATHER'S D'ARSONVAL GALVANOMETER.

THE general convenience of the class of reflecting galvanometers in which a suspended coil moves in the field of a permanent magnet, proposed by Maxwell, but usually known by the name of D'Arsonval, has brought them into extensive use in the course of the last five years. But, as in the case of many other apparently simple instruments, it is only by paying great attention to details that perfection can be attained. In the instruments under consideration the length, breadth, and form of cross-section of the coil have important influences on the result, as also have the manner and material of suspension of the coil. These points have been carefully studied by Prof. Ayrton and Mr. Mather, both mathematically and experimentally, and their results have led to the designing of the instrument shown and described by them at the last meeting of the Physical Society, and illustrated below.



The permanent magnet of circular form, with a narrow gap between its poles, rests directly on the base, and the flat plate which holds it in place also carries a circular level by means of which the instrument may be rapidly set up. The narrow coil, which has a cross section in the form of two circles, having a common tangent at right angles to the mirror, is enclosed in a silver tube. The shape of the coil was arrived at from theoretical consideration by Mr. Mather* as giving the greatest deflecting moment per unit moment of inertia; in this respect the coil is twice as efficient as the older form. The silver tube enables the coil to be suspended

* Proc. Phys. Soc., Vol. x., p. 376.

without straining it, and serves the double purpose of damping the motions of the coil by the Foucault currents which pass up and down it when in motion, and of protecting the coil so as to enable it to be clamped without damage. The coil tube is hung in an outer tube of brass by means of a flat strip of phosphor bronze, and the current is taken out of the coil through an insulated pin in the silver tube by a spiral of flat phosphor bronze; the lower end of which is connected to a contact screw in the outer brass tube. This mode of suspension ensures the centre of gravity of the coil being always directly under the point of suspension, and obviates the sudden tilting which almost always occurred in the older instruments at some position of the coil. The use of phosphor bronze gives us a very elastic suspension, and the flat form provides tensile strength and radiating surface with small torsional rigidity.

The mirror is attached to the coil tube by means of a light three-armed metal clip, and moves in a mirror-box provided with an aperture closed by a sliding glass plate. To clamp the coil and enable the instrument to be carried about, a plug attached to a flat spring presses on the coil tube through a hole in the outer tube. When the instrument is in use the plug is drawn out, and slides down a slot in the spring. This is a great improvement on the old form, in which, after letting down the coil and thus altering the adjustments, the coil was usually wedged in place with bits of paper.

The outer-tube, with its mirror-box and adjusting head, fits a socket between the poles of the permanent magnet, and the act of sliding it in makes the connections. Thus several coils may be kept ready suspended, of different resistances or windings, and any one slipped in place in a few seconds. Thus the advantages of portability, dead-beatness, quickness, and sensibility are combined. As regards sensitiveness, the improvement over the old form is apparent; being, for the same resistance and period, as great as that of a Thomson reflecting galvanometer.

The instruments are being made by Mr. Paul, of 44, Hatton Garden, E.C.

MULTIPHASE TRANSMISSION AND DISTRIBUTION OF ELECTRIC ENERGY.

By A. RECKENZAUN.

(*Concluded from page* 600.)

Prof. Elihu Thomson's Views.

Prof. Thomson, in a recent communication, dwells upon the great importance of the multiphase system for power transmission. Although an advocate and manufacturer of alternating current machines, he is of the opinion that the ordinary alternator is unsuitable for power transmission. "It is essentially non-starting. Too much complication is introduced into the plant by the introduction of elaborate devices for starting."

Referring to the Frankfort-Lauffen plant, Prof. Thomson said that "this experiment was quite successful, so far as the technical matters were concerned. It was not intended as an exemplification of a commercial transmission. It served its purpose in proving the possibility of working with alternating currents of very high potentials, and also showed in a striking manner certain features of the multiphase system."

The Three-Phase Motor.

"The non-synchronous motor becomes, by proper proportioning, practically capable of maintaining a speed which does not vary over a few per cent. from light to full load; it requires no exciting current, and starts under load. In construction, it is simply a structure in which the rotating field set up by the three currents of a three-branched suitably-arranged conductor in a laminated iron mass, called the field, drags around a movable armature carrying a system of closed conductors, in which strong currents are set up by the moving lines from the field, which acts to close its magnetic circuit through the armature iron. Thus the rotating bundles of magnetic lines, in cutting the armature conductor, push such conductor along by virtue of the reaction of the opposing currents set up in the armature conductors or closed circuit. Such motors, not being reversed dynamos, cannot act to generate current if revolved by power. Their great advantage is that they may be placed anywhere where convenient to receive current from the mains direct, as from transformers; they may be started or stopped at will, and have no commutators."

Converting Multiphase into Continuous Currents.

Continuing, Prof. Thomson says:—"There is another important way in which the three-phase currents may be utilised at the receiving end. They may be readily transformed into continuous currents of low potential, or of any potential practicable for commutation. The means for transformation in this case is a motor generator of special construction. It possesses an armature winding and connections, suitable for three-phase currents, a field magnet excited by continuous current from any suitable source and acting on the armature, a secondary winding on the armature, or the same winding as that connected to the three-phase mains, with the usual connections to the segments of a continuous current commutator, upon which brushes suitably adjusted take off continuous currents. These may be used for lighting, for running continuous current motors, &c. Motor generators giving 500 volts continuous current, 220 volts and 110 volts, are easily worked from the same system of three-phase mains. The excitation of these machines may be obtained from their own commuted currents. They are self-propelling after having been started along with the generating plant, or may be easily brought to speed before connecting with the three-phase supply by continuous currents from another machine in work. They can be compounded for drop of potential in themselves and the lines leading to and from them."

Supply of Electricity in a Large City.

The future supply of electricity in a large city for all purposes, at any desired voltage of continuous or alternating current, would involve a system about as follows:—

A generating station conveniently located for obtaining water for condensing, cheap fuel delivery, and ready disposal of ashes; containing huge triple compound condensing engines driving large dynamos, delivering either directly or through transformation high potential three-phase currents; a system of high potential mains for three-phase currents, probably consisting of sets of three conductors with a heavy open braid or network covering, tightly woven on, and drawn into an iron pipe filled with insulating oil, placed underground to avoid atmospheric disturbances; sub-stations containing compounded three-phase motor generators feeding into the street mains at the desired potential for lights and continuous current motors; motor generators feeding currents of suitable potential for street car propulsion; alternating current transformers delivering currents of alternating character at the desired voltage for lighting, and for driving commutatorless three-phase motors.

There is no electrical service which could not receive its supply from such a system. The time is, perhaps, not quite ripe for such a comprehensive scheme, but its advantages are obvious to those familiar with the present conditions of supply in large cities.

High Potentials and Insulation.

Prof. Thomson asks the question, "What are the highest potentials which can ever be made available in electric transmission?" Any answer to this, says the professor, will necessarily imply foretelling the future practice, a very hazardous thing to attempt. Such answer may, however, be taken to relate to either a single-phase alternating system or a multiphase, the only difference being in the number of conductors employed.

With regard to insulation, a layer of good insulating oil, 1 inch thick, between rounded smooth metal surfaces, will equal, in resistance to puncturing, a potential which will cause a spark in air over 30 inches long. Prof. Thomson's tests in this direction point to an approximate relation of 1 to 35 or 40 in dielectric strength between air and good heavy paraffin oil. As nearly as can be estimated, a spark between rounded surfaces at 30 inches in air, represents not less than 500,000 volts, and experiments go to show that such potentials can be "kept down," so to speak, in a bath of oil. Whether the condenser effects of a long line would introduce serious difficulties it is impossible to say, but provided that the rate of alternation or periodicity be kept low

and the insulation maintained by covering every inch of the high pressure conductors in, say, 2 inches thick of oil, it might even be possible to work with 500,000 volts. Such a line is even safer, so far as life risks are concerned, than an overhead line of much less pressure. In fact, it may be said to be practically safe. Any interference with the line is difficult on account of the pipe enclosing it, and on the first weakening of the insulation, or before a break in the pipe became complete, a short circuit of a moderate current would take place, and the fuses be blown at the ends of the line.

Cost of Generation and Distribution.

Mr. W. Lahmeyer in a recent paper read before the Electrotechnical Society of Berlin, referred to the important bearing which a system of electrical distribution from large central stations would have upon industrial undertakings in general, and upon the prosperity of a manufacturing nation in particular. Before the introduction of the multiphase system there were several well-known difficulties in the way of high tension transmission. The practicability of potentials from 15,000 to 30,000 volts has been fully demonstrated in the case of the Lauffen-Frankfort installation, but too much stress has been laid upon the aid of cheap water-power, and nearly all the speculations centred upon the utilisation of waterfalls. The value attached to the generation of electricity by steam power on a large scale has hitherto received too little attention. Many people have not realised the fact of the great difference in the cost of generating power on a large scale, and that produced on a small scale.

Professor Salomon compiled table No. 1, calculated from practical data, which shows the cost of a horse-power hour produced by steam engines of various dimensions with 1,000 and 3,000 working hours per annum. The cost of coal was assumed at 14s. 3d. per ton, and the usual expenses connected with maintenance allowed for. It matters little, for the purpose of this table, what the local conditions as to wages and maintenance may have been, because the relative values will remain the same.

With 1,000 working hours per annum, the cost of a horse-power hour in a 2·5 H.P. engine amounts to nearly fourpence. This will be thought too high by those who do not allow for depreciation of the plant. In an installation of 50 H.P. the cost is at once reduced to 1·21 pence, and in one of 1,000 H.P. to ·7 of a penny, whilst a 10,000 H.P. plant can produce the H.P. hour for a little more than half-a-penny. This shows the well known advantage of generating power on a large scale and distributing it if the cost of and loss in the distribution are small.

In comparing the figures obtained in central stations with a large number of working hours, the economy is much more apparent. The question then will be, what is the loss in energy, and the greater cost of distributing power from a central station to consumers at various distances? Calculations were made for a 10,000 H.P. plant for the distribution of electrical energy over a district having a diameter of 100 kilometres, or 62·14 miles. The costs of such a central station, using the three-phase system, are about as follows:—

Buildings and steam plant	£100,000
Distributing mains	45,000
Electrical plant	100,000
Total	£245,000
Or in round figures	£250,000

The total length of aerial line in this case is supposed to be 300 kilometres (186·42 miles); there will therefore be 900 km. (559 miles) of wire. The price of power in Table 2, referring to this installation, is calculated at the receiving points, full allowance being made for the losses in conversion, as also for depreciation. This table shows that current can be generated at the astoundingly low rate of ·48 of a penny per H.P. hour. The distribution of power over such a large area is scarcely desirable, although the size of the plant may be quite feasible. By distributing the current over a smaller area, the cost will naturally become smaller, and lower potentials than those assumed could be used. The correctness of these figures need not be doubted, but they depend upon the necessity of using overhead conductors. This is the point upon which the whole question turns. In towns there is little sympathy to be expected for overhead lines. But we must try to utilise the great arteries along which commerce flows, the high roads and the railways, for the transmission of power.

Table 3 was originally prepared by Mr. Dihlmann, chief engineer of Messrs. Siemens and Halske, and is converted into English equivalents; it shows the relative costs of overhead and underground conductors when used for the high tension three-phase system. The differences in the case of small powers and short distances are not considerable, because the costs are in a measure dependent upon insulation, and, for mechanical reasons, the diameter of the overhead wire has to be larger than necessary for the given current. Mr. Dihlmann made the mistake in assuming that 10,000 H.P. would be transmitted through one circuit. The idea is to distribute the energy round about the central station. In the case of 1,000 H.P. being transmitted to a distance of 100 km. (62·14 miles), the underground cable would cost ten times as much as overhead bare conductors.

If overhead conductors are prohibited, then the question of transmitting such units as 10,000 H.P. becomes problematic.

With regard to safety, everything points in favour of aerial lines, and the only accident which happened in the Lauffen-Frankfort experiment was in the generating station, and not on the line. There is no difficulty in using potentials of 30,000 volts, if the insulators are tested before being put up. The fact that a few insulators broke down with this potential counts for nothing; we might just as well say that steam boilers must not be used because some have exploded.

TABLE I.

Cost of 1 *H.P. hour in Pence for Steam Engine Installations, Coal costing* 14*s.* 3*d. per ton.*

In small installations without condensation.

H.P.	2·5	5	10	25	50	100
Annual working hours 1,000	3·936	3·156	2·54	1·649	1·212	1·008
„ „ „ 3,000	2·460	1·932	1·54	1·032	·792	·690

In central stations with condensation.

H.P.	500	1,000	2,000	5,000	10,000
Annual working hours 1,000	·822	·704	·652	·570	·509
„ „ „ 3,000	·506	·461	·432	·380	·324

TABLE II.—Central station for 10,000 H.P.

Diameter of District to be supplied, 62·138 *miles* (100 *km.*). *Cost of Installation, including Conductors and Secondary Stations,* £250,000. *Cost of Current in Pence at the point of delivery, with Coal costing* 14*s.* 3*d. per ton.*

Annual working hours.	For 1 kilowatt hour.	For 1 H.P. hour in the case of large motors.
1,000	1·680	1·423
3,000	·930	·790
5,000	·744	·631

Cost of Current in Pence at point of Delivery, with Coal costing 5*s. per ton.*

Central Station, near coal mine.

Annual working hours.	For 1 kilowatt hour.	For 1 H.P. hour in the case of large motors.
1,000	1·495	1·260
3,000	·750	·636
5,000	·566	·480

TABLE III.

Cost of Conductors for Power Transmission with Three-Phase Current and Tensions up to 20,000 *volts, with* 15 *per cent. Loss on a Maximum Load:—*

(1ST.) FOR 100 HP.

Km.	Miles.		Section of wire, Square inch.	Cost in £.	£ per H.P.
				£ s.	£ s. d.
10	6·214	O	3 wires ·0062	356 16	3 11 4
		C	3 „ ·0155	4,825 0	48 5 0
20	12·428	O	3 „ ·0062	713 12	7 2 8
		C	3 „ ·0155	9,650 0	96 10 0
50	31·070	O	3 „ ·0062	1,784 0	17 16 9
		C	3 „ ·0155	24,125 0	241 5 0
100	62·140	O	3 „ ·0062	3,568 0	35 13 7
		C	3 „ ·0155	48,250 0	482 10 0
150	93·210	O	3 „ ·0062	5,352 0	53 10 5
		C	3 „ ·0155	72,375 0	723 15 0
200	124·280	O	3 „ ·0062	7,136 0	71 7 2
		C	3 „ ·0155	96,500 0	965 0 0

(2ND.) FOR 200 H.P.

Km.	Miles.		Section of wire. Square inch.	Cost in £.	£ per H.P.
				£ s.	£ s. d.
10	6·214	O	3 wires ·0062	356 15	1 15 8
		C	3 „ ·0155	4,825 0	24 2 6
20	12·428	O	3 „ ·0062	713 12	3 11 4
		C	3 „ ·0155	9,650 0	48 5 0
50	31·070	O	3 „ ·0062	1,784 0	8 18 5
		C	3 „ ·0155	24,125 0	120 12 6
100	62·140	O	3 „ ·0062	3,568 0	17 16 9
		C	3 „ ·0155	48,250 0	241 5 0
150	93·210	O	3 „ ·0062	5,352 0	26 15 2
		C	3 „ ·0155	72,375 0	361 17 6
200	124·280	O	3 „ ·0093	8,204 0	41 0 5
		C	3 „ ·0155	96,500 0	482 10 0

(3RD.) FOR 500 H.P.

Km.	Miles.		Section of wire. Square inch.	Cost in £.	£ per H.P.
				£ s.	s. d.
10	6·214	O	3 wires ·00620	356 15	0 14 3
		C	3 „ ·01550	4,825 0	9 13 0
20	12·428	O	3 „ ·00620	713 10	1 8 7
		C	3 „ ·01550	9,650 0	19 6 0
50	31·070	O	3 „ ·00620	1,784 0	3 1 5
		C	3 „ ·01550	24,125 0	48 5 0
100	62·140	O	3 „ ·01085	4,369 0	8 14 9
		C	3 „ ·01550	48,250 0	96 10 0
150	93 210	O	3 „ ·01550	7,755 0	15 10 0
		C	3 „ ·01550	72,375 0	144 15 0
200	124·280	O	3 „ ·02015	11,942 0	23 17 8
		C	3 „ ·02015	101,500 0	203 0 0

(4TH.) FOR 1,000 H.P.

Km.	Miles.		Section of wire. Square inch.	Cost in £.	£ per H.P.
				£ s.	£ s. d.
10	6·214	O	3 wires ·00620	357 0	0 7 2
		C	3 „ ·01550	4,825 0	4 16 0
20	12·428	O	3 „ ·00620	713 10	0 14 3
		C	3 „ ·01550	9,650 0	9 13 0
50	31·070	O	3 „ ·01085	2,184 10	2 3 8
		C	3 „ ·01550	24,125 0	24 2 6
100	62 140	O	3 „ ·02015	5,971 0	5 19 5
		C	3 „ ·02015	50,750 0	50 15 0
150	93·210	O	3 „ ·03100	11,760 0	11 15 0
		C	3 „ ·03100	85,125 0	85 2 6
200	124·280	O	3 „ ·04030	18,884 0	18 17 8
		C	3 „ ·03875	183,000 0	183 0 0

(5TH.) FOR 10,000 H.P.

Km.	Miles.		Section of wire. Square inch.	Cost in £.	£ per H.P.
				£ s.	£ s. d.
10	6·214	O	3 wires ·02015	595 0	0 1 2
		C	3 „ ·01025	5,075 0	0 10 2
20	12·428	O	3 „ ·04030	1,890 0	0 3 9
		C	3 „ ·03875	12,200 0	1 4 5
50	31·070	O	3 „ ·10850	10,590 0	1 1 2
		C	3 „ ·10850	98,753 0	9 17 6
100	62·140	O	3 „ ·20150	37,210 0	3 14 5
		C	3 „ ·20150	127,500 0	12 15 0
150	93·210	O	3 „ ·31000	83,850 0	8 7 8
		C	3 „ ·31000	337,500 0	33 15 0
200	124·280	O	3 „ ·40300	143,840 0	14 7 8
		C	3 „ ·40300	603,500 0	60 7 0

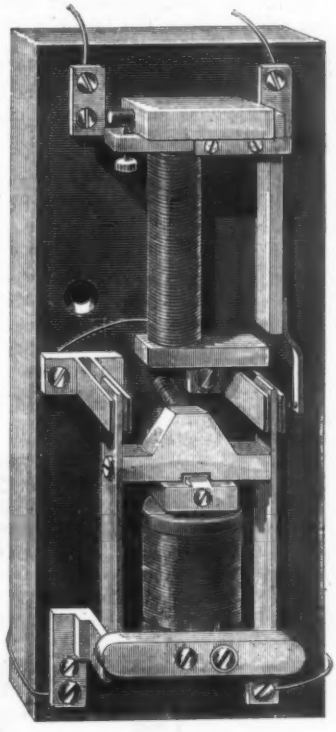
"O" means overhead line. "C" means underground cable.

A NEW CUT-OUT OF THE INTERIOR CONDUIT COMPANY.*

THIS cut-out is designed to be placed in a circuit in a like manner to that in which a lead safety fuse is now connected. It performs in all respects the functions of the ordinary fuse but with much greater accuracy. The instrument consists of a double-pole jack-knife switch, an adjustable relay for setting the cut-out at any load, and a knife resistance release magnet for opening the switch. The entire apparatus is mounted on a slate base with a glass-top mahogany cover, presenting a very neat appearance, besides being of very small size, namely $7\frac{1}{2} \times 3$ inches.

The double-pole switch has a heavy spring tending to keep the switch open. The switch is kept closed by a catch attached to the armature of the release magnet. Placed above the switch is the relay wound with coarse wire which acts as an ammeter, the armature of which will close when energised by a sufficient amount of current, and makes a contact which completes a circuit through the release magnet. The armature of the latter being thereby attracted, the catch is removed and the switch flies open from the action of the heavy spring.

Supposing, for instance, the armature of the relay is adjusted so as just not to close when ten lamps, or whatever number it is set for, are in circuit. As soon as another lamp is added,



the increased current will instantaneously cause the armature to close, when, the release magnet being energised, the switch immediately opens, both poles of the circuit being disconnected. Should it be attempted to close the switch while the overload is still on, the release magnet armature would instantaneously close and refuse to hold the switch down. Should a short-circuit take place, the action would be identically the same. One great advantage of the cut-out is its infallibility. Being once set to open at a certain current, it remains so, no matter how many times it is called into action.

It is as easy to apply as a safety fuse. The mains are connected to one side and the circuit to the other. It makes absolutely no difference to which end the mains are connected and to which end the circuit.

No other connections whatever are to be made, and the whole apparatus is self-contained. There will never be a chance of a three-light fuse carrying fifteen lights before fusing, as happens in many cases. If set for three lights it will always open when this number is increased. The device instantly commends itself to fire underwriters, insurance inspectors and all others who are interested in the continued progress made by the Interior Conduit and Insulation Company or other concerns in the matter of properly safe-guarding electrical conductors.

* New York *Electrical Engineer*.

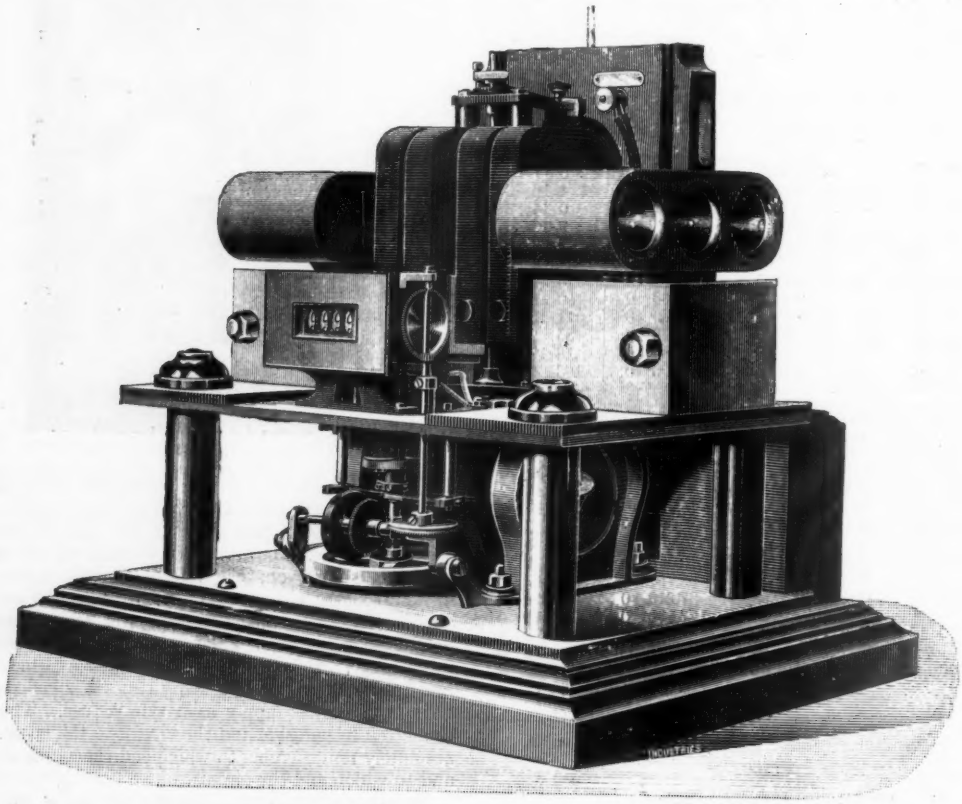
Platinum Pyrometers.—Mr. H. L. Callender has sought to remedy the defects due to want of durability in the original Siemens's platinum wire pyrometer, and which he has apparently traced to the action of impurities in the clay of the cylinder on which the wire was wound, by winding the wire on a thin strip of mica. It is stated that good results are obtainable with the arrangement, no influence being exerted on the metal, even at a temperature of 1,200° C.

A 200,000 WATTS RECORDING METER.

ONE of the largest meters, if not the largest, was constructed some time ago by the Compagnie Anonyme Continentale, Paris, for the company for working metals by electricity at St. Ouen, for a capacity of 2,000 ampères and 100 volts. This meter, of which we give a view taken from a photograph, belongs to the type invented by M. Brillié, and recently introduced into England by Mr. G. P. Roux, and described in the ELECTRICAL REVIEW for April 29th, 1892.

This apparatus has the same dimensions as an ordinary meter of 10 ampères, and only differs from it in the section of the coils of the electro-dynamometer which have only one revolution, which, given the intensity of the current circulating in it, gives 2,000 ampère turns and the size of the terminals, which should be capable of receiving cables of very large section. This meter belongs to the class of motor meters, *i.e.*, it comprises, as an essential, a motive part, to which is imparted a speed in proportion to the current to be measured.

This speed is obtained by the equilibrium of two efforts, one produced by the active couple of the fixed bobbin of the electro-dynamometer on the movable bobbin, *i.e.*, equal and in proportion to E I, and the other produced in the opposite



direction by induced currents developed in a flat disc of red copper, following the movements of the movable bobbin of the electro-dynamometer, and susceptible of being displaced with it. This effort is in proportion to the speed of the magnets, v. Consequently we see that the speed must always be such as to produce an effort, b, which must be equal to the effort exercised by E I = a, *i.e.*, $a - b = 0$.

It follows from this that all the sources of error existing in similar apparatus, due to counter-electromotive force, friction of the brushes, pivots, air, &c., have no influence on the correctness of this apparatus. These passive resistances are in fact overcome by the motor without affecting the speed it should have at a given moment any more, for instance, than the load of a steam engine, provided with a good regulator, affects its speed.

The weakest starting current of this meter is two ampères, or the thousandth part of the total power. The sensibility of this apparatus is moreover easily explained, since the starting is effected as soon as the axle of the movable bobbin of the electro-dynamometer is displaced. The effort exercised by the motor is independent of the effort exercised by the fixed bobbin on the movable bobbin, and depends for a given difference of potential only on the position of the regulating rheostat.

The current consumed by the working of such a meter is insignificant and is in proportion to the load, its maximum being 4 watts. All the advantages possessed by this 200,000 wattmeter, are found in all the other meters of lower intensity for continuous or alternating currents by the same inventor, about a thousand of which are already in use, giving complete satisfaction and representing about 1,500,000 watts.

We are able to give the illustration of the meter through the kindness of the editor of *Industries*, who has lent us the block.

THE TELEPHONE AND THE GOVERNMENT.

THE Telegraphs Bill, as amended by the Committee, has been printed. It contains 13 clauses, of which the majority are formal only. Clause 1 gives power to raise money for the purchase of existing trunk lines, but no powers to compel their sale. Clause 2 provides for the construction of works necessary to give telegraphic communication to the inhabitants of a district, which communication may be at present prevented by occupiers, lessees, or owners; permission may be compelled after an enquiry before the Railway and Canal Commission. Clause 5 extends the powers which may be given to licensees, but contains the most important features in sub-sections (*a*) and (*b*), which limit the exercise of their powers to an urban sanitary district, or such area adjoining as may be defined in the license, and subject also to the consent of the local authority. Clause 6 gives power to an electric light company to permit the placing of telegraphs in their trenches, tubes, or pipes, with the approval of the Board of Trade, the consent of the local authority, and the Postmaster-General.

It will be seen that the Bill contains no provisions to which any serious objection can be taken, except it be Clause 5. This clause is not very intelligible to the lay

mind, but we presume that by it the change in the previous policy of the Government is made, the companies' areas limited, and trunk line construction by them forbidden. The question involved is one of importance, since it revokes previous permissions and limits the bearings of licenses whilst they are in full force. In the evidence brought before the Committee we do not observe any complaint made by the companies to the operation of this clause, so that it may be presumed they are satisfied with it. We are far from desiring that the laws of England should be as the laws of the Medes and Persians; we desire only to raise the question how far it is fair or wise to compulsorily limit or change a license in its mid career.

As we have remarked, that with this exception there is not much in the Bill to complain of, it may be asked why we should have preferred that it should be held over. The answer is, that the objectionable features are not in the Bill, but out of it. The preamble states that "it is expedient to raise money with a view to carry into effect the scheme of the Postmaster-General . . . . for the development of the telephonic system" of the United Kingdom, "and in particular with a view to purchase and provide for the main lines of telephonic communication." If the scheme of the Postmaster-General were defined, the Bill would be more complete, but it is not defined. As will be remembered, from remarks in a previous issue, the scheme of the Postmaster-General includes the creation of an aristocracy of licensees with all the risks thereunto appertaining, to some of which we have drawn attention. The Bill is so far incomplete in that it provides no precautionary measures, and the scheme of the Postmaster-General may be of very much wider scope, for all the evidence the Bill or the report of the Committee contains.

The evidence upon which the Committee passed the Bill bears out our remark that they would be unable to go fully into the matter at this period of the session. The Committee were doubtless impressed by the Post Office evidence showing the small percentage of increase in telegraphic business between certain large towns as compared with the total increase for the whole country. But it is just this evidence which seems to proceed upon narrow lines, and may consequently result in inconvenience. Comparisons over a given period show an increase in "telegraphic business" (not revenue) of 108 per cent. over the whole country, and between certain stated places, having more or less a community of interest, an average of only 62 per cent. The inference drawn is that, if it had not been for the existence of the telephone trunk lines, these districts would have contributed a larger proportion to the telegraphic increase, and the difference between what it is and what it is supposed that it would have been represents the loss incurred. Assuming the correctness of the inference, we are met with the consideration that the development of the telephone business has shown the people of Manchester and Liverpool (to take the first intances given) that for some of their communications the telephone is preferable to the telegraph, and the point of principal public importance is that no additional restriction should be placed on the freedom of that communication which is found to be best. Now the proposals of the Government do place some restrictions on the freedom of communication. As we have repeatedly urged, the divided authorities and the electrical, mechanical and clerical conditions necessarily involved will not facilitate, but will render the trunk communication more difficult. The extent to which the Government will recover its supposed loss, by receiving the revenue from trunk communications, will depend very much upon the profitableness of the trunk lines. It has been urged that the trunk lines are not remunerative in themselves, but are valuable as feeders for the local exchanges. If there be any truth in this, we are face to face with conditions which are exactly contrary to what they should be—a private company is able to take a broad view of the means of remuneration for services rendered over a wide area, and a public department is only able to take a very narrow view as regards telephonic communication, and exactly contrary to the principles which govern it in regard to telegraph communication, wherein, as regards cost, "distance is no object." This is one of the features of the Government proposals which is least satisfactory. It exists not so much in the details as in the essence. The effect is narrowing. It should be broadening. The construction of additional trunk lines will give some increased facilities, but the Post Office, with the supervision of the Treasury, are unlikely to construct trunk lines unless a remunerative trunk business is in prospect, and such lines are not likely to remain unconstructed under private enterprise. It is difficult also to see how the Post Office are to recover their diminishing revenue except by increasing the charges to the public, and it is even questionable whether the interposition of an additional authority between telephone subscribers may not render trunk line communication of less value rather than more. This might tend to drive the public to the telegraphs, but the object of the Postmaster-General is the "development" of the telephone business, not its restriction.

The fact is, as we have so often urged before, that the whole question is one of the first importance, is little understood, requires the most careful handling and the most thorough investigation. It has been treated exactly oppositely in every respect, and the present Bill has been rapidly pushed through Committee at the fag end of a session, and on the threshold of a General Election. It would have been wiser to have waited a little longer, and been a little more thorough.

THE CURRENT THAT KILLS.

III.

NEXT as to the rate of alternation. In all matters of sensation it appears that the human brain is limited in its capacity to appreciate as separate impressions rapid impulses. This has been proved true of most of the senses, and is doubtless true of all. Herein probably lies the reason why the pain caused by electric alternations of low frequency is much greater than that caused by those of high frequency, E.M.F. and current strength being the same.

All shock is of the nature of pain, and the greater the pain the greater the shock, therefore the current producing the greatest pain is also that which will cause the greatest shock. We cannot know exactly how far a simple shock from general causes may possess fatal capabilities, but we do know something of the capacity of electric currents of a certain strength and frequency to produce pain. From this it is reasonable to conclude that a current of low frequency, which when administered in small quantities is found to produce distinct pain, is pretty sure to produce greater pain, and consequently cause severer shock when the strength of the current is largely increased.

Suppose such a current to have been used in the electrocutions, how would its capacity for producing maximum pain affect the *humane* condition? Very little, if at all, and for this reason: Electricity travels with the speed of light, many hundred times quicker than sensory nerve impulses, and consequently the brain would be rendered insensitive, and the subject insensible, by the rush of current long before the sensory nerves could communicate their impression of pain.

It seems, therefore, that if initial shock be relied upon for the fatal effect, the use of a slowly alternating, or possibly an interrupted current is indicated, and certainly not the rapidly alternating one adopted.

Again, though the report under consideration does not say it in so many words, it seems evident that the use of alternating current was decided upon on account of its stronger effect on the nerves and muscles, in the expectation that violent disruptive action would result. That little or no evidence of such action was disclosed by the *post mortems* is not to be wondered at, when the rate of alternation (150 *per sec.*) is noted. The alternations were too rapid to be appreciated (as indicated in Article 1); they practically ceased to possess contractive power, and thus the total effect of the alternating current became physiologically similar to the effect of a steady flow of continuous current.

Further, there is good reason to suppose that current alternating with sufficient slowness, and so producing maximum muscular contraction, might almost instantly so disturb the normal rhythm of the heart's beat, as to stop its action entirely. This has been proved possible in the case of animals, for we find in "Medical Electricity," by Drs. Steavenson and Jones, reference to experiments made upon dogs,

wherein it was found that electric stimuli passed at a rate synchronising with the natural movement of the heart strengthened its action; but that when the rate was altered, so that the one no longer synchronised with the other, the natural action of the heart was overcome—beaten down, as it were—and in a short time completely stopped.

Some such effect as this seems to have been aimed at in a very vague sort of way, based apparently on a general idea that because alternating current, when obtained from medical coils or medical magneto machines (in both of which the rate of alternation is comparatively slow), produced muscular contraction, therefore dynamo generated alternating current must produce far greater action of the same order, no matter what its rate of alternation be. But anything like a rational idea of how such an effect could be best obtained, based upon physiological knowledge and previous experiment seems to have been entirely wanting. The medical experts appear to have entered into considerable rivalry in more or less fanciful theories and speculations, and in a general mixing of physiology and physics. As a further illustration of this we note that during the discussion one celebrated electro-therapist seriously propounded the theory that the criminal knowing what was going to happen "had every nerve and muscle tense with involuntary *resistance*. It seemed reasonable to believe that this nervous tension operated *directly to impede the action of the electricity*." That an expected shock of any nature is generally less severe than an unexpected one, we freely admit, but what has this to do with electrical resistance? The one is a purely nervous phenomenon, the other a definite physical quantity. To carry this theory to its logical conclusion we ought to find the most nervous persons the most difficult to kill electrically, whereas the facts point entirely the other way. Several of the criminals referred to in the report showed great absence of nervousness or fright up to the time the current was applied, and then died hard, as the saying goes, while one (Tice), who has since been electrocuted, showed extreme fear, and is declared by at least one doctor who was present, to have died more quickly and easily than any of the others.

(*To be concluded.*)

THE CHEMICAL THEORY OF LEAD ACCUMULATORS.

By M. G. DARRIEUS.

(*Concluded from page* 761.)

Discussion of the results obtained and of the phenomena of the charge and discharge.

The method followed and the results obtained enable us to proceed to discuss the phenomena of the discharge.

The accumulator, as a source of energy, may be compared to a battery in which, at the commencement, the metal consumed would be hydrogen enclosed in lead in infinitesimal quantities, and the depolarising agent the free persulphuric acid in the liquid and the positive plate.

These fugitive reactions, caused by the phenomenon of over-elevation of the electromotive force known as the *coup de fouet* would soon give place to a battery of another order in which the electrode attacked would be lead in a peculiar molecular condition, which would be transformed (as a final result) into sulphate of lead, and the molecule of oxygen serving as a depolarising agent would be furnished by the reduction of $Pb\,O^2$ to a compound of a lower degree of oxidation Pb O, for instance.

About the reaction that takes place in the negative there can be no doubt; the comparison between the proportions of sulphate of lead and the ampère hours of the discharge shows that the difference is very slight. The difference between the proportion of sulphate of lead generally found in the quantitative analyses, and the figures corresponding to the ampère-hours supplied may be correctly attributed to the preliminary utilisation of the traces of free hydrogen contained in the plate. The variation in the density of the liquid during the discharge furnishes one confirmation more of the reality of the sulphating of the negative.

Taking the average of the figures obtained by a large number of experiments, we find that for a discharge of 319 ampère-hours made with an apparatus containing 17·5 kg. of plates, the density of the liquid varied from 33·3° B. before discharge to 25° B. at the end of the discharge. The accumulator contained 3·47 litres of liquid.

The density of 25° at the end of the discharge corresponds for a total quantity of liquid of 3,470 cc. to 2,998 grammes of water and 1,202 grammes of acid, or a total weight of 4,200 grammes of liquid. According to the hypothesis of the sulphating of the negative at the discharge, the charge decomposes the water and sets free 1 equivalent of sulphate of lead on the negative; the quantity of water electrolysed is, in the example chosen:

$$\cdot03738 \text{ gr.} \times 9 \times 319 = 107\cdot317 \text{ gr.},$$

and the quantity of sulphuric acid formed at the expense of the negative:

$$\cdot03738 \text{ gr.} \times 49 \times 319 = 584 \text{ gr.}$$

At the end of the charge the composition of the electrolyte would be as follows:

Water ...	...	2,998 gr. − 107 gr.	= 2,891 gr.
Sulphuric acid ...		1,202 gr. + 584 gr.	= 1,786 gr.

or a total of 4,677 gr. of liquid, these figures corresponding to a proportion of acid of 38·2 per cent., and consequently to a density of 32·6° B. The difference between this value and that given by experiment 33·3° is very slight, and this result, when compared with the measurements of the sulphate of lead in the active negative material, verifies them. Thus the problem seems solved as regards this electrode, and yet the facts thus explained do not throw a complete light on the subject. How, for instance, can we explain the fact that, since this electrode is nothing but lead, if we take for the negative a plate of ordinary lead well scraped, and with as large a surface as desired, we only get a transitory electromotive force and no appreciable current?

However, in this last case there can be no doubt about the reactions that take place. We are, therefore, compelled to think that the principal phenomena are masked by secondary reactions which we must endeavour to eliminate. As these secondary actions can only be due to the part played by the sulphuric acid, it is necessary to get rid of it in order to get at the principal reaction.

With this object a fully charged accumulator was emptied completely, the liquid at once replaced by a neutral solution of sulphate of soda at the maximum of conductivity, and the discharge was effected in this liquid. Samples of negative active material were taken out before and after discharge; before the discharge there was no trace of sulphate of lead and after discharge there were only very slight traces, not sufficient to be measured, due evidently to the little free sulphuric acid with which the plate was impregnated; the discharge gave 58 ampère hours, with a mean voltage of 1·89 volts, and the density of the liquid did not vary during the discharge.

The capacity obtained is of no importance when we take into account the great internal resistance of an apparatus prepared with sulphate of soda as compared with one prepared with free acid.

The active matter discharged has special characteristics; it is partly soluble in acids. On being heated in the flame of a gas blowpipe, it suddenly becomes incandescent, leaving a residuum of litharge dotted over with bright globules, due to particles of melted lead. This conclusive experiment shows that the active negative matter discharged in the sulphate of soda is a mixture of metallic lead and sub-oxide of lead. This last body, obtained by the calcining at 300° of the oxalate of lead, gives rise, in fact, to the same phenomenon of incandescence.

This experiment, which, in my opinion, is of great importance, seems to show that the principal reaction of the discharge is the sub-oxidation pure and simple of the lead, the sulphate of soda apparatus, in which there is not a trace of sulphating, giving, within a little, the same electromotive force (at the rate of hundredths) as the sulphuric acid apparatus; now sub-oxide of lead decomposes spontaneously, in the presence of sulphuric acid, into metallic lead and sulphate of lead.

The sulphating of the negative would therefore perhaps be effected simply by local action; and by considering it in this way, we could perhaps explain in what respects this

reaction differs from that which takes place in an ordinary leaden plate.

In this last case, in fact, the sulphating is entire, and the lead, being covered at once with a veil of non-conducting sulphate, cannot furnish any appreciable energy; we can understand, moreover, why the sulphate of lead, so justly considered the canker of accumulators by all who have had to do with them, is no longer harmful in the case of the discharge.

Each molecule of sub-oxide, on becoming decomposed, leaves a molecule of lead serving as conductor to that of sulphate, and it is only when the entire mass of material is accidentally sulphated that it is a long and difficult process to reduce the sulphate.

In order to verify by another method the hypothesis of the part played by the sub-oxidation in the discharge, we have only to produce the oxidation ourselves by any means whatever, and to observe the changes obtained in the capacity.

The method employed was to expose to the air some negatives from an apparatus of known capacity, after complete charge, during increasing periods of time; the negatives were then put back into the liquid and the discharge started. Under these conditions we find that the capacity collected diminishes in proportion as the exposure of the plates to the air is prolonged.

For about the same capacity all the discharges are of the same character, and have the same mean electromotive force. If we trace the curve of the capacities as a function of the time of exposure to the air, this curve starts from a point of the axis of the ordinates corresponding to the capacity obtained by an immediate discharge and descends rapidly. It becomes convex towards the origin of the axes and asymptotic at the axis of the times; negative plates that had given 320 ampère hours capacity in a normal discharge giving no more than 32 ampère hours after a month's exposure to the air.

There can be no doubt as to the molecular modification undergone by the plates. The active material is transformed into sub-oxide upon contact with the air; its appearance, as well as the chemical investigation, proves it.

When the plates have been exposed half-an-hour, they become heated. We must add, lastly, that, whatever time the negatives have remained in contact with the air, the density of the liquid at the end of the discharge is always the same as in a normal discharge.

From what is already known, we may conclude then that the quantity of sulphate formed on the negatives is exactly the same in all cases; but, in the experiments described, part of this sulphating is purely local, and is a consequence of the chemical action of the sulphuric acid on the sub-oxide formed, which is proved by the lowering of the density of the liquid when the negative plates are put in. This diminution of density is, moreover, a function of the time of exposure to the air.

It is only fair to mention that the famous Gaston Planté glanced at the hypothesis of the oxidation of the negative.

About the reduction of the peroxide of the positive plate to an inferior oxide there can be no doubt, the quantities of lead soluble in acids increasing in proportion to the duration of the discharge. The tables of analyses, moreover, furnish proof that the sulphate of lead formed is in no way a function of the ampère-hours collected, and that it merely proceeds from local action, due to the couple $Pb O^2$, Pb O in the sulphuric acid. What proves clearly that the sulphate is due to this cause, is that if we allow a discharged positive plate to remain in the liquid, it is little by little completely changed into sulphate, in consequence of the progressive reduction of $Pb O^2$.

Lastly, $Pb O^2$ is really the principal depolarising agent of the discharge, for if we wash and dry a fully charged positive plate to free it from any hyper-oxygenated compound, and employ it as a positive electrode with ordinary charged negatives, we get an electromotive force of 1·93 volts and a normal discharge. In short, the electro-chemical work of the accumulator during the discharge reduces itself to the formation of an equivalent of sulphate of lead on the negatives, and to the reduction, first, of an equivalent of persulphuric acid for a few moments, and then of the peroxide to an inferior oxide during the greater part of the discharge.

At the charge the reverse of these phenomena will occur; there will be the formation of an equivalent of free acid on the negative, corresponding to an equivalent of free lead reduced from the sulphate, and also the formation of persulphuric acid on the positive. This acid, on coming into contact with the positive plate, behaves differently according to whether it is a first charge, or a charge following a discharge. At the first charge, the persulphuric acid is in contact with spongy lead; now, experiment shows that this lead does not pass directly from Pb to $Pb O^2$, for, if we treat the positive plate with hydrochloric acid, we know that there is no disengagement of chlorine until we have supplied at least 20 ampère-hours per kilogramme. Thus the lead passes through a weaker state of oxidation (Pb O, for instance), before becoming $Pb O^2$; these two reactions, moreover, obey the successive equations:

$$Pb + 2 SO^3 + O = Pb O + 2 SO^3 \quad (1)$$
$$Pb O + 2 SO^3 + O = Pb O^2 + 2 SO^3 \quad (2)$$

These two equations, moreover, only agree with the final result, which is always the same, whatever may be the cycle of transformation of the material.

By analogy, in fact, with the results observed under the same conditions on anodes of copper, zinc or iron, which give rise to sulphates, we can explain to ourselves the formation of a persulphate of lead, and it is in fact possible that this body should be generated in the cycle; but we know that it is not stable, and gives rise spontaneously to sulphuric acid and peroxide of lead, for which the chemical equilibrium exists alone.

In the subsequent charges the reactions of the charge on the positive do not occur all in the same manner; in fact, it is no longer lead that exists on the positive—it is a mixture of peroxide, inferior oxide, and sulphate.

The action of the persulphuric acid during the charge has the effect of restoring the whole mass of active material to the state of peroxide; the transformation of Pb O takes place according to equation 2 and that of the sulphate in accordance with the following equation:—

$$S O^4 Pb + 2 S O^3 + O = Pb O^2 + 3 S O^3 \quad (3)$$

This result entirely bears out what we know of the action of persulphuric acid on metals, and especially lead, from the researches of Berthelot and Marshall. There is no doubt, whatever may have been said, that the sulphate of lead may be peroxidised as well as reduced by electrolysis; a plate formed of the sulphate of lead of commerce, placed as anode in sulphuric acid, was little by little completely peroxidised, and the peroxide produced, on being treated with hydrochloric acid, gave off a volume of chlorine amounting to ·32 of a gramme per gramme of material, a value in accordance with those already found.

The medium formed by the active peroxidised material being hyperoxygenated, the persulphuric acid remains in a free state, and the charging is completed. The action of the persulphuric acid in the charge is indispensable; in fact, if we try to charge an accumulator in pure water, a hydrate of lead is formed at the expense of the positive, is electrolysed, and precipitates on the negative a very considerable deposit of spongy lead. We have only to add a few drops of sulphuric acid to the liquid (the density being scarcely 1° B.) in order to make this phenomenon disappear and obtain peroxidation.

We can also produce it in the neutral sulphate of soda and in all soluble sulphates.

The operation is performed more regularly in proportion as the density is greater, persulphuric acid being much more stable in strong liquids.

Application of Thomson's Law.

The application of Thomson's law to the reactions going on is the most delicate part of this study; it was in order to make this formula agree with the results of the measurements that we suggested the theory of the double sulphating which, as we have just seen, does not agree with the analysis made, and which gave for the electromotive force the value nearest to the practical value, this approximation being, in our opinion, merely a coincidence without any scientific accuracy. We will now endeavour to apply this law.

At the beginning of the discharge, the law is in accordance with the measurements; in fact, let there be, on the negative, formation of one equivalent of water, or immediately of sulphate, the result is the same:

	Cal.	Cal.
Heat of formation of one equivalent of water ...	+ 34·5	...
Heat of formation of one equivalent of sulphate of lead	...	36·2
Decomposition of persulphuric acid (exothermic body)	+ 13·2	13·2
	47·7	49·4
Electromotive force as deduced from Thomson's law	2·07 v.	2·15 v.

In both cases, the figures agree with the measurements; they are lower than those furnished by the measurements at the moment of the *coups de fouet* 2·24 v., but the difference may be attributed to the corrective term in Helmholtz's formula, to be added in this case because the accumulator cools during the discharge.

Passing now to the important part of the discharge, which consists in the reduction of Pb O^2, if we apply the formula, the value found (1·32 v.) is evidently far below that which really measures the electromotive force of an accumulator. Nevertheless, this same law is entirely in accordance (with the thermic correction which is to all intents the same for all the couples in question) with the experiments which we are dealing with, couples consisting of the same positive and different negatives, zinc, iron, copper, ordinary lead, &c., in sulphuric acid.

Couples.	Electromotive force according to Thomson's law.	Electromotive force measured.
	v.	v.
Pb O^2 Zn	2·13	2·30
Pb O^2 Fe	1·77	1·97
Pb O^2 Cu	1·07	1·25
Pb O^2 Pb (ordinary)	1·32	1·6

The reduction of Pb O^2 to a weaker oxide is, moreover, confirmed by the above figures; the difference noted with ordinary accumulator negatives is therefore entirely attributable to these negatives. How, in fact, can we explain the difference noted? We are led to ask ourselves, since we know for a fact that the negative active material charged is nothing but lead, whether this lead is not an allotropic modification possessing peculiar properties.

This view is in accordance with the conclusions drawn from the learned researches of M. Schutzenberger on the different molecular conditions of metals, amongst which are copper, silver and lead, and from Dr. Gore's experiments on antimony.

On studying the properties of the metals obtained by electrolysis, these *savants* found that we thus obtained molecular conditions different from those of the ordinary metals; amongst the properties of these metals under a new form, the most important for our purpose is, that they *give off heat on passing to the ordinary state.*

The lead of negatives obtained by the reduction of a salt undergoes an allotropic change; it possesses reducing properties which ordinary lead has not, and could not be entirely assimilated with ordinary lead.

The following experiment shows this indubitably. A plate is formed with any salt of lead whatever, litharge, minium sulphate or chloride. This plate is associated with a zinc plate in water for the last two substances, and acidulated water for the first, and the battery thus constituted is closed upon any circuit whatever. At the end of the operation the salt of lead is entirely reduced, and we draw from the apparatus a plate of spongy lead, which has not been subjected to any action of charge or discharge, and which cannot be anything but lead.

This being done, if we measure the electromotive force given by a positive plate washed and dried in order to free it from persulphuric acid, in the presence of a negative of ordinary lead freshly scraped, we get 1·6 v.; if, *without touching the positive*, we substitute for the soft lead negative that of spongy lead obtained as described above, we get 1·93 v. With a well charged positive the results are higher, but they always keep the same difference—1·9 v. in the first case, 2·13 v. in the second.

This experiment is striking and throws a great light on the hypothesis suggested, showing its great probability; it proves that the difference between the value furnished by the formula and the exact value must be attributed to the negatives; it explains why Thomson's law does not give a value that can be compared to that found practically.

The error committed is in no way attributable to this law, but to the fact that when taking the algebraical sum of the heats of formation we disregard the calories corresponding to the change of molecular condition, which calories, unfortunately, in the works of the *savants* quoted above, have not yet been determined.

If we set an apparatus thus constituted to discharge, the negatives never having undergone any charging, we get the following values:

Weight of plates ...	... 17·5	kg.
Mean intensity at discharge	20·3	ampères.
Mean difference of potential	1·92	volts.
Capacity collected	... 176	ampère-hours.

or 10 ampère-hours per kilogramme.

The examination of these figures, which are identical with those obtained by normal discharges, will remove the least trace of doubt.

To sum up, then, the lead accumulator will henceforth to our knowledge be constituted as follows:—*At the end of the charge* it will consist of a positive plate of Pb O^2 impregnated with persulphuric acid, and a negative plate, Pb, in a particular molecular condition; a growing state, so to say. *At the end of the discharge* of a positive plate containing a mixture of Pb O^2, Pb O (?), SO^4, Pb, this latter produced locally by the couple, Pb O^2, Pb O, in the acid, the total quantity of Pb O^2 reduced being in proportion to the discharge, and of a negative plate formed of a mixture of Pb and sulphate of lead produced by the local action of the acid on the sub-oxide of lead.

In conclusion, I wish to thank publicly Messrs. Liagre and Savreux, former pupils at the Ecole de Physique et de Chimie, whose intelligent and earnest collaboration has greatly facilitated my task, for all the analyses and measurements made in the course of these difficult researches.

THE INTRODUCTION OF THE ELECTRIC LIGHT AT BUDAPEST.

[FROM OUR OWN CORRESPONDENT.]

ON June 15th, the question of the introduction of the electric light at Budapest was finally decided by the Metropolitan Municipal Committee in a favourable manner. It was resolved to grant the concession for the erection of electrical works at Budapest to two establishments, viz., the local gas company, and the firm of Ganz & Co., of Budapest. The latter body had previously declared in their tender that they proposed to erect the works on their system of long distance transmission with alternating current transformers. The gas company, in their tender, did not name any special system; but they afterwards explained that they also purposed employing a system of distant conductors, *i.e.*, a mixed system, a central station with alternating current generators, and further, sub-stations with alternating current motors, which are to set in motion continuous current dynamos, and from which latter accumulators are fed; therefore, on the whole, a system similar to that carried out in Kassel, but which has not been since repeated elsewhere.

In the Commissions which had to examine the four tenders sent in (Gas Company, Ganz & Co., Siemens and Halske, and Egger and Schuckert), the tender of Ganz and Co. was recognised as technically the most perfect, whilst the gas company held out especial financial advantages to consumers. The financial commission, therefore, in its report, expressed itself in the following very characteristic manner:—

"The tender of the gas company is, without doubt, the cheapest, while that of Ganz & Co., from the present point of view of electrotechnics, is beyond doubt the most perfect, and it seems therefore desirable, in the interest of consumers, desirable for the commission to avoid every monopoly and admit of free competition, and along with the now cheapest gas company, which *under present circumstances might protect the consumption of gas to the possible damage of electric lighting and transmission of power*, to grant a concession to an undertaking which is prominent and famous in the sphere of electric lighting."

In order that a real competition may be secured in the sphere of electric lighting, the Finance Committee proposed to obviate the possibility of an agreement between the two concessionaries by suitable stipulations in the agreements.

The metropolitan magistracy accepted this point of view, and submitted the following draft stipulations to the Municipal Committee:—

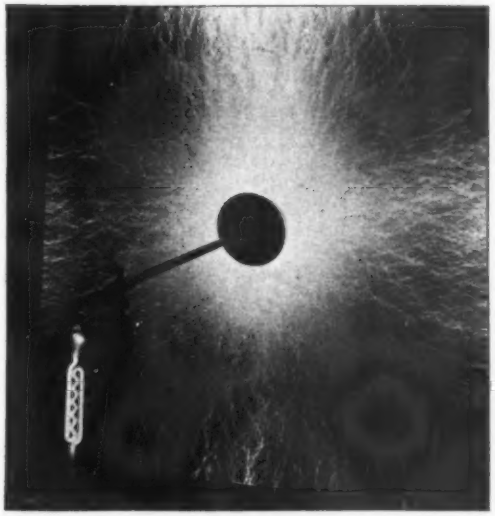
In the first place, the tender of the gas company is to be accepted as the cheapest, but considering that in the interest of the consumers a healthy competition ought to be created, and considering, further, that the tender of the native firm of Ganz & Co. is most excellent in a technical respect, negotiations should be entered upon with both the parties tendering, but upon an equal basis, and under equal conditions, and the commission is entitled to conclude the agreements. The tenders of the two other firms, Siemens and Halske, and Egger and Schuckert, are not accepted.

It was resolved that: the gas company should carry out the Ganz installation as regards the extent of the larger conductive net. That Andrassy Street must be lighted electrically as far as the Town-wood. Severe penalties were to be imposed on all secret agreements.

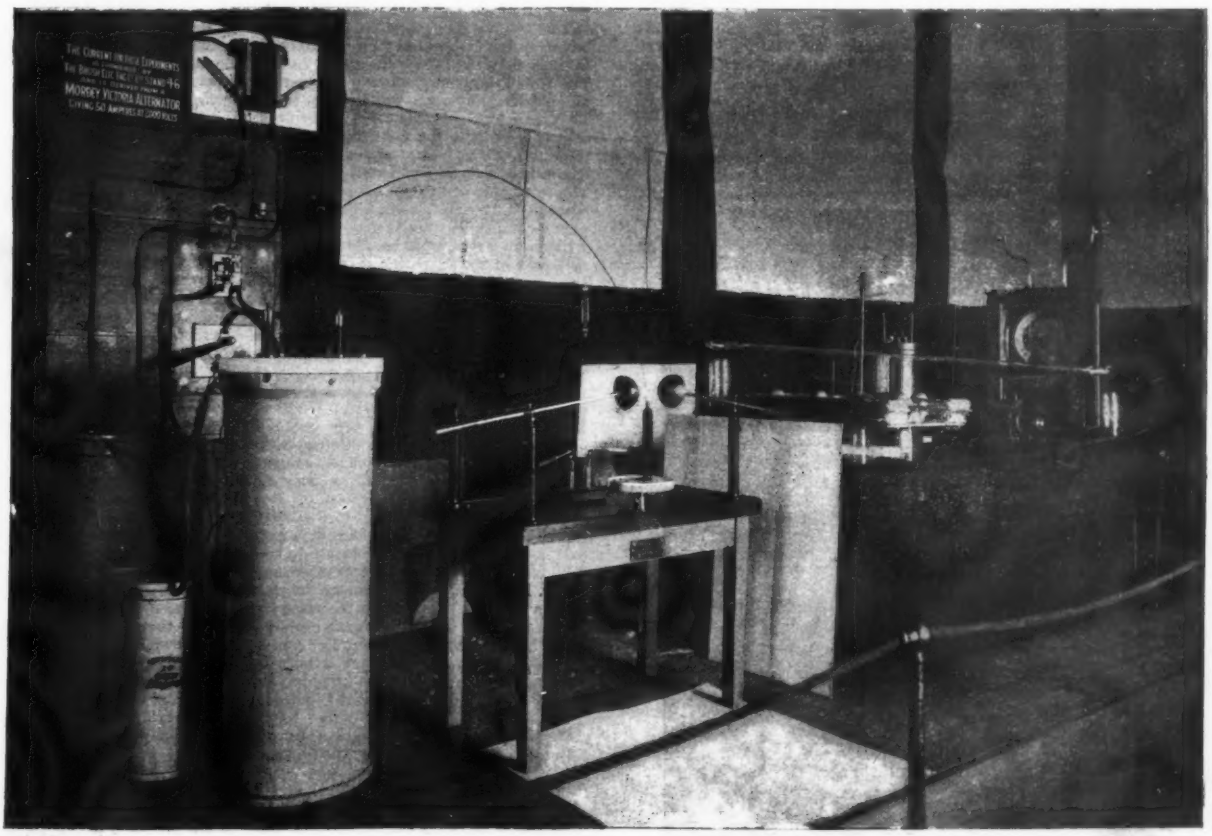
These proposals were adopted by 108 votes against 25. The minority wished to grant concessions to the firms Siemens and Egger and Schuckert. The agreements are now to be concluded with the two concessionaries.

HIGH TENSION APPARATUS.

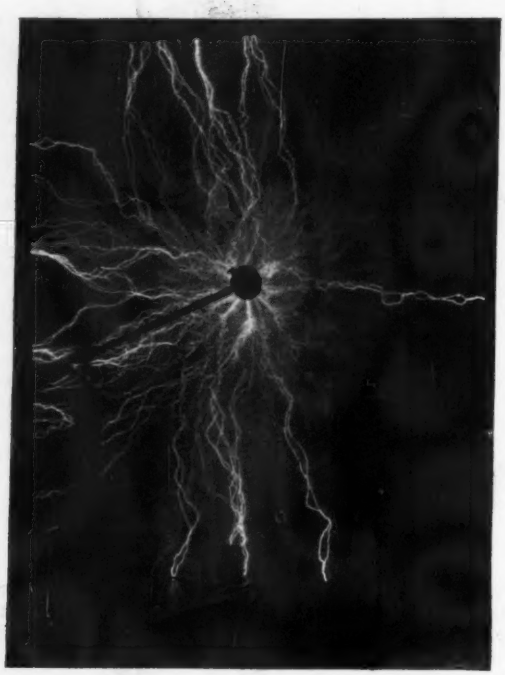
WE illustrate this week the apparatus employed by Messrs. Swinburne & Co., of Teddington, in their experiments with high alternate pressures. We described the experiments, and gave a diagram of the connections in our issue of April 22nd. The high pressure transformer itself is in a large stoneware case. There is really an inner jar filled with oil in which the transformer is immersed, one lead being taken through the side of the jar. This arrangement was adopted to meet the requirements of the insurance companies. The two high pressure wires are led out through the ebonite terminals on the top, and are carried through the air to the terminals on the discharge table, so that there is no chance of leakage or sparking to earth. The high tension voltmeter is seen at the far end of the counter. It consists of a cylinder electrometer immersed in oil. One terminal is connected to the lowest cylinder, and the upper external and the moving cylinder



are connected to the other terminal. The movement works an index. A little consideration will show that it is not a very easy task to make an instrument to take such high pressures without any chance of sparking to earth. The terminals are on the top of two hone-shaped glass tubes. One of these is carried right through the instrument to the bottom of the oil, the oil being in a glass jar. Connection is then



made to the lower cylinder. The other terminal is connected to the index mechanism. As it would have been impossible to insulate the mechanism in the usual way, the whole of the



gear is mounted on a glass plate, and this plate is supported on a corrugated ebonite pillar. The cylinders in the oil are attached to glass rods fixed to the plates.

The jars seen to the left contain the step down transformer reducing the pressure from 2,000 to 150 volts and the regu-

lating gear. The other figures show the phenomenon of the discharge on to a glass plate, or electric octopus, as Messrs. Swinburne call it, and a long arc. The plates are 2 feet in diameter, so that some idea of the appearance of this experiment can be formed.

The photograph of the arc is a little deceptive, as it is not sufficiently nearly instantaneous. The arc is really a long and sinuous flame, but the photograph shows several arcs, one on the top of the other.

The small vacuum tubes are lighted through one terminal showing the high frequency effects produced by the discharge in the electric octopus. In reality the glass plate acts as a condenser, which is charged and discharged disruptively.

The small motor is used for the experiment of transmitting power through a slate pencil. Messrs. Swinburne say that they can transmit one or two H.P. through a human being without hurting him, but a slate pencil is a safer subject. In this experiment 40,000 volts are used, the second transformer reducing the pressure to 100 volts. This motor is interesting as being the first synchronising self-starting alternate motor exhibited in this country. Messrs. Swinburne & Co. regard this machine as experimental, but state that they consider it provides a solution of the problem, and that they expect to have motors of this type on the market shortly.

THE GOVERNMENT AND THE TELEPHONE.

THE Select Committee of the House of Commons on the Telegraphs Bill sat on Wednesday last week, under the presidency of the Postmaster-General. The Bill seeks to obtain power to develop the telephonic system, and to authorise the purchase of the main trunk lines in the country, and for this purpose it authorises the raising of one million pounds by means of consolidated stock.

Mr. CHARLES LAMB, of the General Post Office, gave evidence as to the various groups of telephone companies. In reply to the Postmaster-General, witness said the National Telephone Company, represented, he should think off hand, 90 or 95 per cent. of the telephone business of the country. The gross revenue from telegraphs in 1889 was £2,129,965, in 1890 £2,364,098, and in 1891 £2,456,764. He was unable to give the figures for 1892, but he was sure the result would be much less favourable than the figures quoted. He attributed the falling off to the increased competition of the telephone companies. The New Telephone Company represented themselves and the Mutual Telephone Company. The licenses to these companies were uniform. They were for thirty-one years from the 1st January, 1881, so that every license expires on the same day, and these licenses were for the whole country. There were originally several other telephone companies which had been amalgamated with the National Telephone Company. The telephone companies could be acquired by agreement, or, failing agreement, by arbitration. The restrictions imposed upon the telephone companies were that the communications must be oral, and no written messages must be allowed. Attention had been called to the necessity of the present Bill partly by questions in Parliament, partly by memorials from Chambers of Commerce and other public bodies, partly by articles in the public Press, and partly by the falling off in the telegraphic revenue of the Post Office. Some time ago a return was made, covering a given period, which showed that the telegraphic increase was 108 per cent. over the whole country, whilst between Manchester and Liverpool it was only 72 per cent.; between Glasgow and Leeds, 67 per cent.; between Leeds and Bradford, 79 per cent.; between Leeds and Huddersfield, 73 per cent.; between Leeds and Dewsbury, 51 per cent., and between Glasgow and Greenock only 30 per cent. Considering the large general increase in the telegraphic business of the country, a very large increase might have been looked for in these busy centres, and he attributed the small increase to the competition of the telephone companies. The royalties last year amounted to £40,000.

Mr. LAFONE: Is it not a fact that from 1889 to 1892 there was an increase of capital and an increase in the expense of working, which accounts for the falling off in the revenue?

Mr. LAMB: There has been no increase of capital, but there has been a considerable increase in wages. Witness also gave information as to what the Department proposed to do as to the erection of main lines of wires between London and Glasgow, Edinburgh and Belfast. The heaviest copper wire would be used, so as to secure thorough efficiency. It was intended to establish telephonic centres in the country, and to connect these centres with powerful through wires. There would be "spurs" to Newcastle, Hull, Manchester, Liverpool, Sheffield, Nottingham, Derby, Leicester and Bristol. The capital required to carry out the objects of the Bill was estimated at one million sterling. Numerous communications had taken place between the licensees in connection with the scheme, and the concessions the General Post Office were prepared to make them. The companies, he believed, were not entirely satisfied. They had intimated that an extension of their licenses would be an important element in their assenting to the scheme. Witness then went into an elaborate calculation as to the capital of the telephone companies, which he estimated at four millions. In about 19 years hence their plant would not be worth more than one million; and they ought now to be setting aside a sum to place them in possession of three millions at the end of 19 years. The main difficulty with the telephone companies was the extension of their licenses. No determination had been come to on that point. He considered the extension

of licenses for seven years would be equivalent to giving them £700,000. It was one of the chief points of the scheme of the Government to establish telephonic communication with Ireland at once. They could not speak to Calais nor to Berlin. A man at Dover could speak to Paris through London. They could speak to Marseilles from London, but not very satisfactorily.

Colonel HILL asked if it was possible to establish Transatlantic telphonic communication.

WITNESS did not think it was possible yet.

Mr. J. S. FORBES, chairman of the National Telephone Company, Limited, in response to the invitation of the Committee, made a statement, in the course of which he said that the company, understanding that the Government considered the acquisition of trunk lines an essential part of their policy, would on this question be prepared to concur in that policy and loyally co-operate in developing it; they would be prepared to sell these lines to the Post Office and abandon the right to construct further lines on terms to be arranged, among which were that the company were to be entitled to the exclusive use of the existing lines till the Post Office has constructed a sufficient number of additional lines to supply the service called for by the public. The company would pay to the Post Office from the date of transfer the tariff rate to be fixed by the Post Office for trunk messages on all trunk lines; the Post Office on their part undertaking to provide from time to time such additional trunk lines as the company might in their discretion require to maintain an efficient service. He also proposed other mutual terms between the department and the company.

The Committee then adjourned.

The Select Committee met again at the House of Commons on Thursday, the following being present: the Chancellor of the Exchequer (in the chair), the Postmaster-General, Mr. Cully, Mr. Wm. Cross, Mr. J. E. Ellis, Sir Edmund Hill, Mr. Atherley Jones, Mr. Lafone, Mr. Leon, Mr. Summers, and Mr. Taylor.

Mr. J. S. FORBES, chairman of the National Telephone Company, who was again called as a witness, urged that in crowded localities it was necessary to lay the wires underground, and not overhead, and that further powers of interference with the streets should be given. When the companies failed to obtain from individuals or localities permission to lay their wires, he thought the Post Office should step in to provide that the desired communication should not be prevented unreasonably. His proposal with regard to the purchase of the companies' trunk lines, was that they should be taken over at the cost price, as the figures stood on the books of the companies, along with the obligations as to wayleaves. He did not think the Post Office should take them over at a depreciated cost, but they would have to leave that matter. Part of the money taken for the surrender of the companies would probably be in money down and part in deferred pay. In answer to questions put by the Chancellor of the Exchequer and the Postmaster-General, witness laid them on the contention that it was necessary to get further powers to enable them to lay underground wires, the Post Office to step in where local authorities or individuals stood in the way of the work being carried out. As to purchase, not only should the cost price on the books of the companies be given, but also a sum equivalent to the unearned increment in respect of the 19 or 20 years they had carried on business. There was not the least doubt that the inefficiency of the telephone system, as well as its expansion, had been greatly hampered and indeed retarded for a great number of years by this want of power on the part of the companies, whether the wires were single or double. In London, Liverpool, and other crowded areas a metallic circuit was absolutely necessary, so that further underground powers should be given. The companies in 1892 found themselves with no more powers than they ever possessed since they came into existence. In 1885 the department found it was essential that more powers should be obtained for the companies, but they had never yet been given.

Mr. WALLACE, director of the New Telephone Company, was next called, and said his company was not actually capitalised at the present time. They had three acquired licenses, each of which carried with it the right to lay down wires throughout the country. Of course, they could only act as a company under one of the three licenses. All the licenses would have to be given up by his company if the Bill became law, and they had to part with their lines to the Government. His company were willing to enter into an arrangement such as the one proposed, on certain conditions—if wires were leased to them, and they were perfectly convinced that with the Government proposals the whole scheme would be of great benefit to the country.

The CHAIRMAN said the committee would next hear the solicitor to the National Telephone Company, who, he believed, wanted to be heard.

Mr. WINTERBOTTOM, the witness referred to, said he desired to be heard as to the powers to be given the companies by the Bill. His directors thought the Bill as it stood was insufficient to enable them to do their part as a public company. It authorised the Postmaster-General, if he thought fit, to delegate to his licensees some of the powers of the Telegraph Acts, but Clause 5, as it stood, would give no underground powers at all. Since they began their work a great deal had been said about putting their wires underground, but this clause, as it stood, would simply apply to wires overhead, and would not touch the underground. They thought Clause 5 ought to be so amended as to include the whole of the underground powers as well as the overground. The local authority must consent to any interference with the streets, and it was only with the consent of the local authority that the wires could be laid underground; but the Act of 1878 gave power of appeal to the companies, and witness thought a similar power of appeal ought to be given under Clause 5 of this Bill. When the Post Office took over the telegraphic system they found it impossible to carry it out without such a power, The lines of his and other companies would not be of any great service to the public or the department unless they were connected with the trunk lines. The Act of 1878 was devoted principally to giving the right of appeal. To allow the local authorities to impose conditions on any one company and give the latter no right of appeal would be a very serious blow. He did not think the local authorities should be allowed to impose conditions—it would be unjust to allow each separate authority to impose its own. As to giving supplies, the companies never refused a supply if they could only get a wayleave, but the local authorities ought to have no power to impose conditions under this head. If unfair conditions were imposed, for instance, in Liverpool, they would be felt in Manchester and other places, if not throughout the whole system; and by the Postmaster-General also. He thought that in accordance with the policy of the Act of 1885 the powers referred to should be given to the companies as licensees. The Bill contemplated the Post Office laying underground wires between exchanges, which was not satisfactory.

The POSTMASTER-GENERAL: You are, perhaps, not aware that it is part of the Post Office scheme—though too much a matter of detail to be mentioned here—to provide interchange cables.

The room was then cleared for the purpose of giving the committee an opportunity of consulting in private. When the public were readmitted,

Mr. FREKE was called. He said he represented a large number of owners, including the Bedford estate and the Portman estate. He wanted an addition to clause 2, to make it clear that the placing of the telegraph or telephone wires should not deter the owners from raising their buildings, or building new premises if they thought necessary. The Act of 1863 gave such powers, and that was what he now wanted. There was a point at the end of the Bill about costs; under this Bill as it stood they would come under the Railway and Canal Act as regarded costs. In all other cases of the kind the costs were not left to the absolute discretion of one party; for instance, in the Land Clauses Act. He thought owners should be protected from having to pay the costs of the other side, especially when they had not acted unreasonably. He also objected to the upsetting of bargains which companies had made for the fixing of poles or wires.

The POSTMASTER-GENERAL: The meaning of your contention is that instead of having a discretion, the arbitrators should be bound to award the costs unless they thought them unreasonable in amount.

WITNESS: If there is a reasonable ground for opposition, although the owner may not succeed, it is not fair that he should have to pay the costs of both sides.

The CHAIRMAN: Is there any other point?

WITNESS: In clause 4 there is an objectionable feature.

The POSTMASTER-GENERAL: This clause would enable the Post Office to reopen an objectionable agreement before a proper tribunal would it not?

WITNESS: Yes.

The Chairman here intimated that they would have the room cleared again.

Mr. BAKER said that as the representative of some 150 local authorities, he wished to say that if the committee thought of making any alterations in clause 5, he should like to be heard on the subject.

The Chairman promised to bear the application in mind.

The room was then cleared.

Mr. GOSCHEN, when the public were readmitted to the room, said the Bill was mainly for enabling Parliament to obtain one million sterling for the purpose of purchasing the trunk lines of the telephone companies, if the arrangements contemplated could be carried out, and for the erection of further trunk lines subject to terms to be made with owners of property and others. The telephone companies had been heard on the subject, but they had dealt chiefly with the details of the Bill. On most of the points raised the Committee gave no opinion; but one point was, whether their licenses, originally granted for 31 years, should be extended or not. The companies asked for a considerable extension of their present terms, but the Committee did not recommend that the terms of the licenses should be extended. They thought the agreements should be laid before Parliament, and that the responsibility for any extension should rest upon the Government. Mr. Goschen added that the Bill, as altered in that Committee, would be reprinted.

LONDON COUNTY COUNCIL'S OVERHEAD WIRE BYE-LAWS.

THE electrical trade section of the London Chamber of Commerce are taking action in reference to the bye-laws which the County Council have framed for the control and regulation of overhead wires in the County of London, under the Act of 1891, and are presenting through the Chamber of Commerce a petition to the Board of Trade, of which the following is a copy:—

LONDON OVERHEAD WIRES ACT, 1891.

LONDON COUNTY COUNCIL BYE-LAWS.

To the Right Honourable Sir MICHAEL HICKS BEACH, Baronet, Member of Parliament and President of the Board of Trade.

The Petition of the Incorporated Chamber of Commerce of London humbly showeth:—

1. That your petitioners on behalf of its electrical trade section are interested in the "Bye-laws made by the London County Council in pursuance of the London Overhead Wires Act of 1891," and objections to which are shortly to be heard, and the clauses finally settled by your department.

2. That having considered the bye-laws which the London County

Council are empowered to frame under the Act, your petitioners have arrived at the conclusion that many of the provisions are wholly impracticable and would place such insurmountable difficulties in the way of the companies interested as to prevent them carrying on their business, and are quite unnecessary for the public safety.

3. That your petitioners aver that the companies fully realise that it is in their own interest and that of the electrical industry generally, that proper safeguards should be provided for the safety of the public from accidents arising from carelessness in the erection or maintenance of overhead wires.

4. That your petitioners are prepared to co-operate, if need be, in the framing of any reasonable legislation for the proper control and regulation of overhead wires in the County of London, and would wish to indicate that they regard the bye-laws framed and recently passed by your department for the regulation and control of overhead wires in the provinces as being generally reasonable and such as will not stultify and hamper the development of the industry, while at the same time sufficiently safeguarding public interests.

5. That your petitioners object to clauses 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 19, 20, and 21 of the regulations as now framed by the County Council, the reasons, where such are given, being here set opposite the numbers of the clauses referred to.

Interpretation of Words.—That the interpretation of "company," as including "person," may be taken to mean any person using a wire, *e.g.*, a subscriber to a telephone company.

Clause 1.—That the "plan" which is required is in excess of the powers granted to the London County Council under Clause 5 of the London Overhead Wires Act of 1891. That the regulation is an impracticable one. That to comply with it a special staff of clerks and inspectors would require to be continually employed in view of the constant changes which are being made in the routes of wires to suit the requirements of telephone subscribers. That the attendant expense would be very serious, and even if practicable the time allowed (three months) is much too short.

Clause 2.—That the requirement of 14 days' notice, giving particulars of the wires proposed to be erected, is far too long, inasmuch as wires have frequently to be erected and removed at a day's notice, *e.g.*, in the case of visits of Royal personages and also police requirements, where only a few hours are allowed. That, even in ordinary circumstances, it would be impossible to comply with the regulation, the route of the wire having to be so often changed in the course of construction. That the provincial bye-laws recently settled by the Board of Trade under the Public Health Act provide only for a *route form* without drawings, being sent in one month *after erection*, and this, it is contended, would be sufficient in the case of London.

Clause 4.—That to require that all wires shall not be at a less height above the roof of any building than 7 feet would, unless accompanied by compulsory wayleaves, make overhead wires almost impossible in some districts of London, owing to the irregularity of the buildings. The enforcement of the clause would be a serious interference with the use of poles and standards. The height can add neither to the safety of the wire or its supports, nor, consequently, to the safety of the public. No such provision has been insisted on in the provincial bye-laws.

Clause 5.—That the London County Council should have power to permit an excess of 140 yards in special cases.

Clause 6.—That it is impossible to determine the angle in the case of many of the London streets, owing to their irregularity. That no similar regulation is contained in the provincial bye-laws.

Clause 7.—That the words after "length of span" should be deleted, so as to correspond with the provincial bye-law.

Clause 8.—That no restriction should be placed on the companies which would prevent the use of copper, as would be the case if this clause were insisted on. The enforcement of the clause would necessitate the removal of the present wires and the substitution of others, if, indeed, it is possible to find a wire by which the factor of safety required under the conditions could be guaranteed.

Clause 9.—That the word "pole" should be substituted for "support."

Clause 10.—That the terms of the bye-laws are in excess of the powers conferred on the London County Council under the Act. That no such enactment is provided for in the provincial bye-laws.

Clause 11.—That this clause is a most unreasonable restriction, which, as has been proved by past experience, is quite unnecessary. That at least four times as many wires are carried on the present poles, and that to require that only 20 shall be erected where so many have hitherto been used with safety, is to aim at the total and complete extinction of the entire overhead system, and consequently at the stoppage of all telephone exchange business in London.

Clause 12.—That cables are now in use weighing 6 lbs. per yard, and have not proved to be in any way dangerous; and further, that they have been erected for years weighing 2 lbs. per yard, instead of 1 lb., as mentioned in the clause, and that not a single case is known of a broken cable. That even if practicable, the carrying out of the clause would prove to be so costly as to be absolutely prohibitive. Moreover, that experience proves it to be quite unnecessary, and that it is beyond the powers conferred by the Act.

Clause 14.—That to insist on the shoes of supporting poles being of iron, is to restrict to an old-fashioned system which might prevent the adoption of improved methods. That no such provision is contained in the provincial bye-laws.

Clause 15.—That there is frequently great difficulty in efficiently connecting the wire to earth. That owners and tenants of property have grave objections to the erection of lightning conductors, and often refuse sanctioning the erection of any wires on such a condition. That a lightning conductor might prove to be a source of greater danger than protection to tenants of buildings. That such a provision is not contained in the provincial bye-laws.

Clause 19.—That for this clause, No. 3 of the provisional bye-laws should be substituted, which reads:—"Every wire or tube, after it has ceased to be used for the purpose for which it was stretched or placed, or for some similar or other proper purpose, must be removed, unless its owners intend, within a reasonable time, again to take it into use."

Clause 20.—That the Act does not provide for inspection and that the clause is therefore *ultra vires*. That in any case it should be deleted, it being unreasonable to suppose that the companies can contract for the invasion at any time of business or domestic privacy.

Clause 21.—That the words "or any of the provisions of the London Overhead Wires Act, 1891," should be deleted, your petitioners being of opinion that the local authority has only power to impose penalties for the violation of its bye-laws, and that a violation of the provisions of the Act can only be dealt with under common law procedure.

Your petitioners, for the reasons given, are of opinion that the London County Council bye-laws as at present framed are utterly impracticable, and so unworkable as to defeat the object they have in view, which object your petitioners are interested in promoting by all reasonable means. That the bye-laws should therefore be amended by your department in accordance with the views here set forth, and which will no doubt be supported by the independent testimony and technical knowledge of the representatives of the companies interested, and that while efficient safeguards for the public safety ought to be provided, this, it is contended, can be done without ruthlessly interfering with the ordinary business methods of not only a growing but an indispensable industry to the public convenience.

And your petitioners will ever pray, &c.

Given under the common seal of the London Chamber of Commerce, incorporated, this 16th day of June, 1892.

REVIEW.

Electric Motor Construction for Amateurs. By C. D. PARKHURST. Bubier Publishing Company, Lynn, Mass., U.S.

This is an unpretending little book, printed on capital paper, and finished in a better style than is usually found in this country. The matter is, as the title says, written for amateurs. We do not doubt but that a small motor could be built from the description given, yet it would have been much easier if a properly dimensioned scale had been attached to figs. 1 to 12; as it is, much is left to chance, and we are afraid of the result. The type of motor chosen is suitable for the small outputs proposed, and the general details are sufficiently strong to work well, excepting the mounting of the armature. The author proposes to mount the shaft in a wood centre, which in turn will carry the armature by friction against the windings: surely some easier and more positive method could have been suggested. This is going back to the old Schuckert rings. The section on Primary Batteries will be valuable to the amateur who uses bichromate cells. It contains some useful hints gathered from practice.

NOTES.

Proposed Testimonial to Mr. Varley.—A meeting, attended by Messrs. R. E. Crompton, T. E. Gatehouse, W. A. Gorman, Prof. D. E. Hughes, T. Parker, Major Flood Page, A. Stroh and J. W. Swan, was recently held at the rooms of the Institute of Electrical Engineers for the purpose of discussing the best method of recognising the great services of Mr. Samuel A. Varley to the electrical industry. The meeting was unanimously of opinion that Mr. Varley deserved substantial recognition, and that everyone interested in electric engineering should be invited to join the committee for the purpose of discussing the best form that this recognition should take, and that a draft circular should be prepared ready for submission to a meeting of a committee, which should be invited to attend at the rooms of the Institute of Electrical Engineers at 28, Victoria Street, S.W., on Friday, July 1st, at 4 o'clock.

Electric Lighting for Berwick.—The Berwick Town Council have agreed to employ a consulting engineer to report upon the best system of electric lighting for the town.

Dublin Electric Lighting.—At a recent meeting of the Dublin Corporation a report of the electric light committee, which recommended the acceptance of the tender of Messrs. Edmundson & Son for the wiring of the civil buildings at the price of £1,298 15s. was adopted.

The Electric Light at Worcester.—The Mayor and Corporation of Worcester, accompanied by their advising engineers, have paid a visit to Bath for the purpose of examining the Bath Electric Lighting and Engineering Works. It is proposed to spend about £30,000 upon an installation for Worcester on the high-tension alternating system.

A New Electrolytic Process of Preparing Tannin Extracts, &c.—This new adaptation of electricity to the requirements of the art of tanning may be briefly described in its essential features as follows :—The liquors obtained by the extraction of such raw tanning materials as chestnuts, oak-bark, divi-divi, &c., are brought to a density, corresponding to 4° B. at 17½° Centigrade, and drawn off into a tank. To every 10,000 litres of such liquor, 500 grammes of oxalic acid, and 2 kilogrammes of sodium chloride, dissolved separately in water, are added. The liquid is then heated to a temperature of 60° Centigrade, and subjected to electrolysis. The electrolysis has for its object the clarifying and bleaching of the tannin extracts or tanning liquors. The electric current, besides decomposing the oxalic acid and the sodium chloride, produces, by some obscure reaction, a voluminous deposit between the electrodes, which deposit consists chiefly of resinous matters, cellulose and colouring matters, that is to say, the action results in an elimination of substances which are other than tannin from the liquors and extracts. The electrodes are made of netting mounted in frames, and formed of platinum wire. No details are given concerning the strength of the current, except that it depends upon the quantity of liquid that is to be dealt with, and on the time in which the bleaching and clarification are to take place.

The Estimation of Chlorine in Electrolysed Solutions.—The production of chlorine, hypochlorites, and chlorates by the electrolysis of such solutions as that of common salt, has become quite a feature during the last few years of the application of electricity to the manufacture of chemicals on a commercial scale. In connection with this development the need has been experienced of good methods by means of which the liquors may be estimated and the processes governed so that they may be exploited with profit. Rapid volumetric methods of examination have become a necessity, for the solutions have to be frequently tested. By the direct electrolysis of aqueous solutions containing sodium chloride at ordinary temperatures liquors are obtained which contain undecomposed sodium chloride, also sodium hypochlorite and sodium chlorate. This general action is undoubtedly true in regard to other chlorides. No sodium chlorate appears to be formed, and if the temperature is raised to 50°—55° C. (Rigaut, *La Lumière Electrique* V. xl. p. 102) the liquor mainly contains the chloride and chlorate of sodium. These electrolysed solutions may be very conveniently examined by the following methods, namely :—(*a*) Estimation of chlorine combined as hypochlorite ; (*b*) estimation of chlorine combined as chloride ; (*c*) estimation of the total chlorine. These methods are not new, but it may be well to call attention to them as being the most suitable. With regard to the third method it might seem at first thought that the total chlorine could be obtained by the titration of the original solution which had been electrolysed, but this is not the case, as during the electrolysis of a chloride solution there is a decrease in its volume caused by the rise of temperature due to the current, so that the contents per cubic centimetre of the solution before and after electrolysing are not comparable, unless in the latter case the solution is carefully brought to its original volume by the addition of water. A further error is introduced by loss of chlorine due to its escape into the air during the electrolysis. The most satisfactory agent for use in this method for reducing purposes is a saturated solution of sulphuric acid (Rose *Handbuch* ii., p. 613. Leipzig, 1871). In testing the efficiency of electrolytic chlorine generators it is most convenient to absorb the chlorine produced in sodium hydrate solution. These methods are applicable to the examination of bleaching powder in cases where the estimation of total chlorine and chlorate is desirable. For further details our readers may consult a paper in *Technology Quarterly*, 1892, pp. 361—364, by L. M. Norton, Ph.D.

The Separation of Gold and Silver from their Ores Electrolytically.—A method of performing the above process has recently been proposed which presents the following essential features :—A solution of common salt is prepared of such a strength that the specific gravity is 1·15. To this solution is added from ½ per cent. to 20 per cent. of barium or calcium acetate, 1 per cent. to 10 per cent. of oxalic acid, and ½ per cent. to 2 per cent. of cyanide of potassium. Before treating the ore with this solution it is finely powdered, either roasted or not. The prepared ore is now placed upon a porous diaphragm, the latter being supported in a vat, whilst the solution, prepared as above, is pumped through it. The solution may be assisted in its action with great advantage by an electric current passing between a carbon anode placed beneath the diaphragm, and a copper cathode placed in the liquid above the ore. The dissolved gold and silver are separated by passing the liquid through shavings of an alloy of zinc, with some electro-positive metal, such as potassium or sodium ; 2½ per cent. of this metal may be used, and it is of advantage to add a trace of cadmium.

An Electrical Process of Purifying Brine.—Brine is by no means simply a solution of sodium chloride or common salt, it may and usually does contain various impurities which if not eliminated, will affect the quality of the salt that is deposited. The most common of these impurities are the carbonates of iron, calcium and magnesium, which occur frequently, together with the sulphate of lime and the chlorides of lime and magnesia. It has recently been discovered by C. G. Collins of Woodsburgh, U.S.A., that these objectionable impurities can be eliminated by passing into the brine an electric current having an electromotive force of about 2½ volts—not more. The sodium chloride is not acted upon by a current of this strength whilst the above impurities are rendered insoluble so that they sink to the bottom of the vat containing the brine and can be separated off. As an example of this action, we may take the action of the current upon the bicarbonate of lime which is a frequent impurity of brine. This bicarbonate is electrolysed and the carbonic acid which it contains bubbles off from the anode, and calcium hydrate forms at the cathode ; the molecules of this latter substance being in a nascent state immediately attack some of the molecules of undecomposed bicarbonate and converts it into the monocarbonate of lime, which being insoluble quickly settles down. The sediment collects at the bottom of the vats and is discharged at intervals whilst the purified brine is tapped off at a higher level. There is another and highly ingenious way of working this process. It consists in forcing the liquor and the mixed precipitate under hydrostatic pressure through a filter-bed in which are embedded the electrodes of another battery, by means of which the redissolving of the precipitated impurities is prevented.

Magnetic Leakage in Dynamos. — According to *Industries*, a great deal of energy that might be better spent is wasted over the discussion of the waste field in dynamos. In spite of the spread of knowledge of magnetic circuits, there still seems to be a fallacy lurking in the subject. Many writers still seem to think that a certain number of ampère turns on the field must produce a corresponding total number of lines of induction, and that if a large proportion of these pass round the armature, there will be fewer left available to go through. This is a complete misunderstanding of the question. The only effect of increasing the leakage is to produce more lines. They do not cost anything, and do not matter, except for one thing. They decrease the permeability of the field magnets, so they demand slightly more iron in the fields. The only bearing leakage has on dynamo design is in altering the permeability of the fields. A compound dynamo, for instance, should not have its field permeability too high at no load, or its pressure will be unstable ; on the other hand, at full load the permeability should not be so reduced that too much excitation is needed to give the desired pressure. Various methods of constructing ironclad dynamos still appear from time to time. Another form of the same fallacy consists in winding the field excitation round the armature, to ensure that all the lines shall go through the armature. This results in ruining the ventilation to gain nothing.

The Attraction between two Discs Separated by a Dielectric.—Mons. Julien Lefèvre has succeeded in measuring the attraction between two electrified discs separated by a dielectric which is not in intimate contact with them. A description of the method employed constitutes the substance of a communication to the Academy of Science, Paris. The attraction, under the circumstances examined, can be expressed mathematically by the following formula

$$\frac{F}{F'} = \left(\frac{e + e'}{\frac{e}{K} + e'}\right)^2,$$

where

F' = the attraction stress between the plates at the distance $e + e'$ in air.

F = the attraction at the same distance when a thin lamina, the dielectric constant of which is K, the thickness e, and, having parallel faces, is placed between the discs.

(e' therefore represents the sum of the thickness of air between the lamina and the electrified discs.)

Other formulæ are given and particular cases discussed, whilst tables giving the values for various kinds of paraffin, sulphur, ebonite, turpentine, &c., are arranged at the end of the paper. Mons. Lefèvre observes in conclusion that the attraction of two plates affords a perfect means of measuring the dielectric constants; that the method is simple and rapid and, indeed, preferable to every other that has ever been used. For details our readers must consult the *Comptes Rendus*, Vol. cxiv., pp. 834—836.

The Examination of Iron and Steel by Electrolysis.—Electrolytic methods continue to find favour with those who have occasion to examine the character of the metals, and to report upon them. The following process is a new one and is recommended by Messrs. T. M. Drown and A. G. McKenna in the *Technology Quarterly*. Dissolve five or ten grammes of a sample of iron or steel in sulphuric acid, evaporate until white fumes begin to come off, add water and heat until all the iron is in solution; filter off silica and carbon and wash with water acidulated with sulphuric acid. Make the filtrate nearly neutral with ammonia and add to the beaker in which the electrolysis is to be made about one-hundred times as much mercury as the weight of metal first taken. The bulk of the solution should be from 300 to 500 cc. Pass a current of about two ampères over night, in the morning test for iron, and, if necessary, continue the electrolysis after adding enough ammonia to neutralise the acid set free. Finally, remove the solution from the beaker with a pipette while the current is passing. When as much has been removed without breaking the current add water, and continue the operation until the acid has been so far diluted that there is no danger of dissolving iron from the mercury. Take the anode out and wash the mercury. After filtering to remove any flakes of manganese dioxide, add sodium phosphate in excess, and ten grammes of sodium acetate. Make nearly neutral with ammonia and boil for forty minutes. The precipitate of aluminium phosphate is then filtered off, ignited and weighed: thus the aluminium present may be determined.

Hydrobromic Acid by an Electrical Method.—A large quantity of bromine can be converted into hydrobromic acid very rapidly by the following electrical process:—A glass tube, 7 inches long and $\frac{5}{8}$ths inch in diameter, is fitted at each end with a cork carrying a piece of small tubing and a piece of stout wire. The ends of these pieces of wire within the longer tube, are joined by a spiral of platinum wire one inch in length, and after expelling the air the spiral is heated to bright redness by an electric current. A stream of hydrogen impregnated with bromine by bubbling through that liquid, which may be heated to 60° C., is passed through the longer tube, and, as long as a slight excess of hydrogen is maintained, hydrobromic acid quite free from bromine issues from the other end, and is collected in water. There is very little danger of explosion, but to render it impossible, the small supply tube may be plugged with glass wool. This method is due to G. S. Newth, who contributes a paper on it to the *Chemical News*.

The Electric Lighting at Keyham College.—The Treasury have approved of an expenditure of about £400 for lighting the Engineer Students' College at Keyham by electricity, this amount being required to cover the cost of wiring the building and the purchase of batteries.

A Curious Point in Electrolysis.—Vortmann's recent process for the quantitative estimation of nitric acid by electrolysis is, according to A. Becker, based upon the formation of a hydrogen alloy. Vortmann electrolyses the nitrate in the presence of sulphuric acid and some metallic salt, for example sulphate of copper. During the electrolysis, metallic copper is deposited, and hydrogen gas is evolved, but neither of these is capable of effecting the reduction of nitric acid to ammonia. Yet this is the result of applying the galvanic current. As there is, however, in Vortmann's new process, no doubt about the reduction, Becker concludes (*vide Chemiker Zeitung*, xiv., p. 1,557), that it is affected by an alloy which is formed between the copper and the hydrogen. In his opinion, the reduction would take place instantaneously in the presence of an alloy of palladium and hydrogen.

Magnetic Variations and Earth Currents.—In a recent paper "On the Simultaneity of Magnetic Variations at different places on occasions of Magnetic Disturbance, and on the relation between Magnetic and Earth Current Phenomena," by William Ellis, F.R.A.S., Superintendent of the Magnetical and Metereological Department, Royal Observatory, Greenwich, it was stated that a comparison for 31 days, between 1880 and 1891, of cases of sudden magnetic movement and earth current at Greenwich, shows the earth current to precede the magnetic movement by 0·14 minute, equivalent to 8 seconds. The general result is that in the definite magnetic movements preceding disturbance the magnets at any one place are simultaneously affected; also that in places widely different in geographical position the times are simultaneous, or nearly so, a small constant difference existing at some places which may be real or may be accidental, but the character of which it seems desirable to determine. It is shown also that at Greenwich definite magnetic movements are accompanied by earth current movements which are simultaneous, but that neither magnetic irregularities nor ordinary magnetic variations seem to admit of explanation on the supposition of being produced by the direct action of earth currents.

A Question which does not Concern Mr. Preece Alone.—Under this heading *L'Electricien* comments as follows upon the question which arose in the House of Commons respecting Mr. W. H. Preece, and which was published recently in the ELECTRICAL REVIEW on page 748:—"We take this opportunity to protest strongly against similar abuses systematically occurring in France. In our opinion Government servants should be rigorously restricted to the fulfilment of their duties from which they derive such great advantages. To be a Government engineer, or to be connected with municipal administration, does not necessarily involve the competency required in the study and examination of industrial questions. It has fallen to our lot, and to that of many others, to go through notes and reports drawn up by engineers occupying an enviable position under Government. What a tissue of commonplace remarks, contradictions and cuttings from reviews, in which little regard is paid for accuracy, and all expressed in the most commonplace style. These same engineers, by bringing their administrative influence into the domain which should be reserved exclusively for the capabilities of civil engineers, represent what we have agreed to term official science and competency. This would explain the disdain with which they are treated by the many that feel ill-disposed towards them. Official science and industry have the effect of retarding private enterprise. Let us, therefore, keep the Government element out of our relations with industrial life; as its machinery is of little advantage to any but the Government officials. We call the public attention to these crying abuses, and ask Ministers and Government authorities to put them down promptly and energetically. We, however, wish it to be understood that these remarks, although suggested by Mr. Preece's case, are not intended to attack him personally, for we hold him in great esteem."

Bristol Electric Lighting.—At a meeting of the Bristol Town Council, a report from the electrical committee was adopted with reference to the provision of steam alternators and dynamos and Lancashire boilers and accessories at the central electric lighting station at Temple Back, and recommending the council to accept the tender of Messrs. Siemens Bros. & Company, Limited, of £11,691, for alternators and dynamos, and of Messrs. Tinker Bros., of £7,732 2s. for boilers. It was stated that there had been delay in consequence of unexpected difficulties in the foundations at the works, but the contractor was pushing on. The committee had hoped to get some light probably about Christmas, but they would not give a definite promise.

Abnormal Earth Currents.—A correspondent (D. B. Grandy) in the *Electrical Engineer* (American), describes a curious case of an apparently permanent earth current on a telegraph line, he says:—"We have another instance of a permanent earth current in one of our city wires. The wire extends about five miles to a point in the south-western part of the city where it is "grounded" on the water pipes in a manufacturing establishment, several blocks away from any electric railway or line of telegraph wires. On grounding this wire at the main office, a negative current with an E.M.F. of 15 volts shows itself. This current has remained at its present strength for over five years, and fluctuates but little. The current is amply sufficient to work the wire without the use of any battery."

A Method of Increasing the Bleaching Power of Chlorine by Means of Electricity.—By this new method chlorine gas is treated in the same way as air when it is desired to produce ozone from the atmosphere. The apparatus employed in effecting this treatment is very simple: it is of two forms. In the first there are two glass cylinders each closed at one end and fused together at the top, one being placed inside the other. The chlorine passes by a tube at the bottom of the outer cylinder into the annular space between the two and then out near the top. The inner cylinder contains sulphuric acid as one electrode, while more sulphuric acid, in which the outer tube is immersed serves as the other electrode. In the other form of apparatus the chlorine gas passes by a zigzag course between flat glass vessels, alternately + and −, containing sulphuric acid. The polarity is rapidly changed in the usual way.

Personal.—We hear that Mr. Douglas Wells, M.I.E.E., M. American I.E.E., Superintendent of Telegraphs and Engineer to the Bahamas Colony, also Consulting Engineer to the Colonial Government, who laid the Nassau (Bahamas)—Jupiter (Florida) cable last January, has resigned his position. He superintended the fitting up of the cable huts and offices, and erected 11 miles of land line in New Providence, copper wire and iron poles being used. He also established the system of working through to Jacksonville through 211 knots of cable and 405 miles of land line on the closed circuit American system, with great success. A rate of 35 words per minute direct between Jupiter and Jacksonville has been obtained. There are seven small stations between Jupiter and Jacksonville. With the exception of the Havana cable this is the only submarine cable which is worked on the closed circuit system, in which sounders are used.

Coast Communication.—The text of the Royal Commission to inquire into the communication with lighthouses and light vessels was gazetted on Friday last. The commissioners are the Earl of Mount Edgecumbe, Sir Edward Birkbeck, Sir F. L. M'Clintock, Sir G. Strong Nares, Mr. John Cameron Lamb, Mr. R. C. Munro Ferguson, Mr. Edward Graves, Mr. J. A. Kempe, and Mr. H. L. Mulholland. The commission will have power to inquire into and report upon what lighthouses and light-vessels it is desirable to connect with the telegraphic system of the United Kingdom by electrical communication for the purpose of giving information of vessels in distress or casualties at sea or places from which assistance can be sent, and of transmitting storm warnings, having due regard to the practicability of establishing and maintaining such communication without impairing the efficiency of the light service.

Taunton Electric Lighting Works.—At Taunton Town Council meeting last week, it was resolved by ten votes to five, to purchase the Taunton Electric Light Works at a cost of £9,300, from the company which is now carrying them on, and subject to the consent of the Local Government Board for the borrowing of the money.

The Electric Light in Greece.—The central electric station at Athens is to be enlarged during the present year. At the end of last year the station was supplying current to 94 arc lamps and 5,631 incandescent, as against 82 arc and 3,838 incandescent lamps supplied with current at the end of 1890.

The Electric Light in Spain.—The Spanish agents of the Allgemeine Electricitäts Gesellschaft, of Berlin, have secured the contract to instal 800 16-C.P. lamps in the Casas Consistorrales at Barcelona. The same firm are also erecting the central station at Santander. Experiments are about to be made as regards the electric lighting of Oviedo.

Islington Electric Lighting.—At last Friday's meeting of the Islington Vestry the special electric lighting committee presented a recommendation that a provisional order authorising the vestry to supply electricity in the parish should be applied for. The committee had arrived at this decision after exhaustive research and the advice of an eminent engineer; and they had come to the conclusion that it was possible to give the supply at 5d. per unit, as against 6d. in St. Pancras and 8d. as mentioned by other promoters.

Pacific Cable Soundings.—The *San Francisco Chronicle* states that the United States survey steamer *Thetis* arrived at Honolulu on May 20th from Hilo, where she ended the survey for the cable to be put in between San Francisco and the Hawaiian Islands. The course to Hilo comprised 2,060 miles as surveyed by the *Thetis*, with 300 soundings, against the survey of the *Albatross* of 2,150 miles and 250 soundings. The soundings were made at intervals of two, ten, and sometimes one mile. The deepest was 3,228 fathoms, about 245 miles north-east of Hilo, and the shallowest was 976 fathoms, at a point about 350 miles from Point Conception. Were it not for this abrupt rise the course would have been almost level. The route traversed by the *Thetis* is considered by the officers as the most practicable yet surveyed.

Bradford Electric Supply.—At last week's meeting of the Bradford Town Council, the minutes of the gas and electricity supply committee, which included a resolution accepting the tender of Messrs. Thornton & Crebbin for providing and fixing the ironwork required in the extension of the electricity works at Bolton Road for the sum of £1,132 were adopted. Alderman Priestman explained that it was absolutely necessary for the satisfactory continuance of the business of the electricity works. During the last six weeks no fewer than nineteen applications had been made for the supply of the current. He ventured to say that before next Christmas the whole of the corporation's plant would have been taxed to the uttermost, and that before long there would unquestionably have to be further extensions.

Liquefying Oxygen and Common Air.—At a recent lecture at the Royal Institution some very interesting experiments were shown by Professor Dewar with reference to the liquefaction of oxygen and common air; these gases were shown in a liquid form in open vessels, from which they could be freely poured. The liquid oxygen was strongly attracted between the poles of a powerful magnet remaining suspended round the poles of the latter. The magnetic property was stated to be about 1,000 times greater than that of iron. The cooling of a body increased its magnetic power; thus cotton wool cooled by liquid oxygen was strongly attracted by the magnet; with reference to this experiment, however, we may remark that it was not suggested whether this attraction was due to the substance of the wool or to the air clinging to its fibres.

Theatre Lighting in America.—The commissioners of the district of Columbia recently gave notice that all the theatres of Washington must be fitted throughout with electric lights.

New Cable between New Zealand and Australia.—We hear that the Government of New Zealand is considering the question of laying an electric cable to Australia at the estimated cost of £150,000.

The Current that Kills.—In the last paragraph of this paper, which appeared in our issue of June 17th, for "effective current" read effective result, and for "fatal current" read fatal shock.

The Electric Light in the Argentine Republic.—The town of Rosario, in the Argentine Republic, was experimentally lighted with the electric light last year. As the result has been satisfactory, it is intended to light all the principal streets in this way. This mode of illumination is also being adopted in many of the private houses.

Central London Railway.—The select committee of the House of Commons, to whom was referred all the London electric railway schemes, having declined to consider in the present Parliament, the scheme promoted by the Central London Railway Company to extend their authorised railway from the Mansion House to Liverpool Street station, the promoters have come to an arrangement with the whole of the opponents, numbering upwards of ten, whereby no further opposition will be offered to this extension in either House.

Electric Light at Llandudno.—In addition to the installation at Craigside Hydropathic referred to in our Notes a fortnight since, Mr. Golding's Private Hotel, in Church Walks, has recently been completely fitted for electric lighting, the contractors in this case being Messrs. T. L. Hemming and Co., of Birmingham. There are 60 incandescent lamps of 16 C.P. in the house, and two arc lamps of 1,000 C.P. for the exterior. A Campbell gas engine of 6 H.P. is employed to drive a Hemming dynamo, accumulators being used for storage, so that the machinery need only be run for a few hours daily at a period of the day most convenient.

Great Strike of Telegraphists in Spain.—In our issue of April 29th, we stated that a strike among the telegraphists in Madrid of a very extended nature seemed inevitable. The Spanish Government, it appears, has since then carried into effect their proposals regarding the reduction of certain bounties, and the amalgamation of the telegraph corps with the post office staff. On Monday last, says the *Daily News* correspondent, the whole system was paralysed, Madrid being completely cut off from the provinces, and the Government had to use the private wires of the railway companies to send their orders to the other towns for the military engineers and authorities to take over the telegraphs, and get up a staff at any cost to replace the disaffected officials. There is not a single line working in the interior of Spain, and the only means of communication with foreign countries is by the cables from Bilbao, Barcelona, Vigo, and Lisbon.

Millers' and Bakers' Exhibition.—The International Milling and Baking Exhibition which opens at the Royal Agricultural Hall, London, on June 28th, and continues open until July 8th, promises to be of unusual interest. In a prospectus the promoters state that in consequence of the fearful ravages caused by mills firing (the result, generally, of employing the present milling machinery, which generates without destroying, a very dangerous dust, &c.), millers, in conjunction with the insurance companies, are suffering from what is actually a national loss, and the insurance companies, apart from insisting on the "average clause," have just recently raised their tariffs to almost the highest existing rate. To reduce this risk, millers are naturally looking for some genius who will show them a milling system by which this evil can be minimised, and it is hoped that the Exhibition may bring out some latent talent which will destroy this great enemy of the trade. The Agricultural Hall, it is stated, has never contained such a vast collection of machinery in motion as will be on view at the forthcoming Milling and Baking Exhibition.

Electric Lighting at Oxford.—The central station at Oxford was formally opened on Saturday by the Mayor. We propose in our next issue to give a full description of this interesting station.

Yarmouth and Electric Lighting.—At a special meeting of the Yarmouth Town Council, held last week, the following resolutions were agreed to:—(1.) That Messrs. Crompton, Messrs. J. E. H. Gordon & Company, Messrs. Woodhouse and Rawson, Messrs. Hammond, the Planet Electrical Engineering Company, and the Brush Company be asked to submit schemes with estimates at which they would be prepared to carry out an installation suitable for the requirements of the town, and that the Borough Surveyor be instructed to furnish plans and the necessary particulars. (2.) And that the committee be authorised to employ a consulting engineer to advise them on the specifications and tenders.

NEW COMPANIES REGISTERED.

Electrical Coal Cutting Contract Corporation, Limited.—Capital £402,000, divided into 60,000 ordinary shares of £5 each, 20,000 deferred shares of £5 each, and 2,000 founders' shares of £1 each. Objects: To acquire and develop certain patents relating to the application of electricity to machinery for cutting coal and other minerals; to enter into and carry into effect an agreement already prepared and expressed to be made between the Woodfield Syndicate, Limited, of the one part, and the Corporation of the other part, and to carry on the business of colliery proprietors, coke manufacturers, coal cutters, contractors, electricians, electrical contractors, electrical and mechanical engineers, suppliers of electricity, and manufacturers and suppliers of and dealers in electrical apparatus. Signatories (each with 100 ordinary and 5 founders' shares), Sir Archibald C. Campbell, Bart., M.P., Blythswood, Renfrew; Lindsay Wood, J.P., The Hermitage, Chester-le-Street, Durham; Hon. G. W. Winn, Nostell Priory, Wakefield, Yorks; J. R. Knowles, Westwood Ince, near Wigan; S. Rivington, Kilmeny, Wimbledon, S.W.; Walter T. Goolden, 28, Westbourne Park, W. (electrical engineer); Frank Stobart, J.P., Biddick Hall, Fence Houses, Durham. The number of directors is not to be less than five, nor more than 10, the first to be appointed by the above-named signatories. Qualification, 5 founders' and 100 ordinary or deferred shares, or 200 ordinary or deferred shares. Remuneration as the corporation may from time to time in general meeting determine. Registered on the 18th inst. by Lake, Beaumont and Lake, solicitors to the company, 10, Lincoln's Inn, W.C.

London and Suburban Messenger and General Agency Company, Limited.—Capital, £25,000 in £1 shares. Objects: To establish and carry on the business of general messengers, carriers, and agents, in such place or places in the United Kingdom (either in connection with the electric call system and the telephone system, or one of them, or not), as the company may from time to time determine. Signatories (with one share each): R. King, 3, Old Serjeant's Inn, Chancery Lane, W.C.; J. S. Burn, 161, Keston's Road, Bermondsey, S.E.; J. Millar, 9, New Cavendish Street, W.; J. Anderson, 50, Bedford Row, W.C.; J. G. Dalzell, The Clock House, Arundel Street, W.C.; A. H. Embery, 23, Avondale Square, Old Kent Road, S.E.; T. Y. Killey, 95, Great Saffron Hill, E.C. The regulations of Table A to the Companies' Act, 1862, mainly apply to this company. Registered on the 18th inst. by J. G. Dalzell, one of the signatories.

Universal White Lead Syndicate, Limited.—Capital, £45,000 in £5 shares (3,000 preference, 5,800 ordinary, and 200 founders'). Objects: To acquire and take over as a going concern the Electric White Lead Works carried on at Deptford and elsewhere, and all the letters patents granted to E. V. Gardner, and with a view thereto to enter into the agreement referred to in clause 6 of the articles. Signatories (with 1 share each): C. Billett, 5, Copthall Buildings, E.C.; E. V. Gardner, Florence Road, New Cross, S.E.; G. Jennings, 28, Gracechurch Street, E.C.; B. F. Babcock, 17, Water Street, Liverpool; B. Radcliffe, 28, Chapel Street,

Liverpool; H. A. Mandeville, Anner Castle, Clonmel; W. B. Foulger, 6, Lime Street, E.C. The number of directors is not to be less than three nor more than seven, the first to be elected by the above-named signatories. Qualification: 100 shares of £5 each. Remuneration as the company in general meeting determine. Registered on the 16th inst. by Redpath, Holdsworth and Marshall, 23, Cannon Street, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Oriental Telephone Company, Limited.—In our issue of June 10th we stated that the name of this company had been changed to "The Oriental Telephone and Electric Light Company, Limited." This, however, should be "The Oriental Telephone and Electric Company, Limited."

The official sanction to the change of name from "The Oriental Telephone Company, Limited," to the above title, was granted on the 30th ult., with the approval of the Board of Trade.

Chelmsford Electric Lighting Company, Limited.—The registered office of this company is situated at The Arc Works, Chelmsford, Essex. (Filed on the 21st ult.)

Elmore's French Patent Copper-Depositing Company, Limited.—The annual return of this company, made up to the 6th ult., was filed on the 18th ult. The nominal capital is £200,000 in £2 shares. All the shares have been taken up, of which 33,250 have been issued as fully paid. Upon the remaining shares the full amount has been called, resulting in the payment of £133,015 6s., leaving £484 14s. in arrears. Registered office, 64, Cannon Street, E.C.

Electricity Supply Company for Spain, Limited.—The annual return of this company, made up to January 7th, 1892, was filed on April 30th, 1892. The nominal capital is £100,000 divided into 19,900 ordinary and 100 founders' shares of £5 each. All the shares have been taken up, of which the founders have been issued as fully paid upon the ordinary shares. The full amounts have been called and paid. Registered office, 15, St. Helen's Place, E.C.

Elmore's American and Canadian Patent Copper Depositing Company, Limited.—The statutory return of this company, made up to the 17th ult., was filed on the 31st ult. The nominal capital is £200,000, divided into 65,000 priority and 35,000 deferred shares of £2 each. 44,788 priority and 35,000 deferred shares have been taken up, of which the deferred shares have been issued as fully paid. Upon the priority shares the full amount has been called, and £80,319 paid, leaving £9,257 unpaid. Registered office, 64, Cannon Street, E.C.

Indo-European Telegraph Company, Limited. The annual return of this company, made up to the 11th ult., was filed on the 19th following. The nominal capital is £450,000, divided into 18,000 shares of £25 each. Of these, 17,000 have been taken up, upon all of which the full amount has been called and paid. The total amount of shares, for which share-warrants, comprising one share each, are outstanding, is £82,950 (or 3,318 shares). The total amount of share-warrants, comprising £25 stock or 1 share, issued since last summary, is £1,100, and the total amount of share-warrants, comprising £25 stock or 1 share, surrendered since last summary, is £175.

Metropolitan Electric Supply Company, Limited.—The annual return of this company, made up to the 20th ult., was filed on the 2nd inst. The nominal capital is £500,000, divided into 49,900 ordinary and 100 founders' shares of £10 each. All the shares have been taken up, of which 2,132 have been issued as fully paid. Upon the remaining shares the full amount has been called. The calls paid amount to £478,271 9s., and unpaid to £408 11s.

Mining and General Electric Lamp Company, Limited.—The following notice was filed on the 30th ult.: "At an extraordinary general meeting of the above-named company, duly convened and held on Tuesday, May 24th, 1892, the subjoined extraordinary resolution was duly passed: 'That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same, and accordingly that the company be wound up voluntarily, and that James Howard Hays, of 11, Abchurch Lane, London, E.C., be, and is hereby appointed liquidator for the purposes of such winding up.'"

Western and Brazilian Telegraph Company, Limited.—The annual return of this company, made up to the 26th ult., was filed on the 2nd inst. The nominal capital is £1,500,000, divided into 66,871 shares of £15 each, and 66,258 shares of £7 10s. each. Of these, 64,242 of the former, and all of the latter class, have been taken up, and the full amount called. The calls paid amount to £1,460,565, and £565 has been paid on 75 shares forfeited. Share warrants, each comprising 5 shares to the value of £1,725, and each comprising 1 share to the value of £225, are outstanding, and share warrants to the value of £2,550 have been surrendered since last summary.

Chamberlain and Hookham, Limited.—The annual return of this company, made up to April 26th, 1892, was filed on the 11th ult. The nominal capital is £100,000 divided into 5,000 "A" and 5,000 "B" shares of £10 each. 1,000 "A" and 5,000 "B" shares have been taken up, and the "B" shares have been issued as fully paid. Upon the "A" shares £3 10s. per share has been called and paid. Registered office at the offices of Messrs. Archibald Kenrick and Sons, Limited, Spon Lane, West Bromwich.

Marshalls, Sons and Company, Limited.—The annual return of this company, made up to the 13th ult., was filed on the 19th ult. The nominal capital is £400,000, divided into 10,000 shares of £20 each, and £200,000 consolidated stock. At the time of making up, 2,000 shares and all the stock had been taken up, and a call of £1 per share had been called and paid. Registered office, Britannia Iron Works, Trinity Street, Gainsborough, Lincoln.

Ransomes, Sims, & Jefferies, Limited.—The annual return of this Company, made up to April 28th, 1892, was filed on the 3rd ult. The nominal capital is £500,000, in £100 shares. 3,075 shares have been taken up, of which 2,185 have had the full amount called, and 890 shares have had £50 per share called, resulting in the payment of £263,000. Registered office, Orwell Works, John Street, Ipswich.

Southampton Electric Light and Power Company, Limited.—The annual return of this company, made up to the 6th inst., was filed on the 11th inst. The nominal capital is £30,000 divided into 4,000 preference and 2,000 ordinary shares of £5 each. Ten preference and 688 ordinary shares have been taken up and the full amount called. The calls paid amount to £3,364 and unpaid to £126. Registered office, 23, High Street, Southampton.

West India and Panama Telegraph Company, Limited.—The annual return of this company, made up to the 31st ult., was filed on the 8th inst. The nominal capital is £2,445,630, divided into 200,000 ordinary, 34,563 first preference, and 10,000 second preference shares of £10 each; 88,321 ordinary, all the first preference, and 4,669 second preference shares have been taken up, and the full amounts called. The calls paid amount to £1,275,530. Registered office, Dashwood House, Old Broad Street, E.C.

Islington and General Electric Supply, Limited.—The capital of this company has been raised from £900 to £250,000 by the creation of 49,820 shares of £5 each. (Filed on the 21st ult.)

Veale and Company, Limited.—The registered office of this company is situate at Menacuddle Street, St. Austell, Cornwall (filed on the 3rd inst.)

Electric and General Investment Company, Limited.—At extraordinary general meetings of this company, convened and held at 1 and 2, Great Winchester Street, London, E.C., on the 11th and 26th ult. respectively, the following special resolution was duly passed and confirmed:—"That the new regulations submitted to and approved by the meeting, and intituled 'Articles of Association of the Electric and General Investment Company, Limited,' and for the purpose of identification subscribed by the chairman thereof

be and they are hereby adopted as the regulations of the company to the exclusion of, and in substitution for, all the existing regulations of the company." (Filed on the 1st inst.) Registered office, 1 and 2, Great Winchester Street, E.C.

Anders, Elliot and Chetham-Strode, Limited.—At an extraordinary general meeting of this company, held at 10, Bush Lane, Cannon Street, E.C., on May 31st, 1892, the following extraordinary resolutions were duly passed :—1. That it has been proved to the satisfaction of this meeting that the company cannot, by reason of its liabilities, continue its business, and that it is advisable to wind up the same voluntarily. 2. That Francis Henry Ebsworth, of 1, Arthur Street East, in the City of London, be, and is hereby appointed, liquidator of the said company. (Filed on the 1st inst.)

Latimer Clark, Muirhead and Company, Limited.—The annual return of this company, made up to the 12th ult., was filed on the 20th following. The nominal capital is £100,000, in £10 shares. 4,709 shares have been taken up, upon each of which the full amounts have been called and paid. Registered office, 23, Regency Street, Westminster, S.W.

BUSINESS NOTICES, &c.

Electrical Work on the Thames.—A patent has been applied for by Mr. W. S. Sargeant for an electric port, starboard, and masthead light in one, fitted with very powerful cut-glass lenses and polished reflectors. The illuminating power consists of three incandescent 16 C.P. glow lamps, and two switches control the port and starboard lights, and another the masthead light; when the launch is at anchor the latter can be used as a riding light. The whole arrangement is very sightly, and can be switched on at will at any time. It has great advantages over the old method of having three separate lamps burning oil, which at all times is objectionable, especially on board an electric launch, where cleanliness is one of the advantages claimed for electrical propulsion. On the trial very excellent results were obtained, the lights being visible a mile off. Four of these lamps are now being made, and they will be used on electric launches. One is now fixed on Mr. Andrew Pears's electric launch, *Glowworm*, which has been thoroughly overhauled and decorated throughout this season; her speed now is 9½ miles an hour, which makes her the fastest electrically-propelled vessel on the Thames, with the exception of the *Metadel*, which was designed and moulded by Mr. W. S. Sargeant for the Delta Metal Company, she being built of delta metal. The electrical power on this boat consists of 40 E.P.S. accumulators, 19 plate T type, and one of Messrs. Immisch's motors (6-inch), rotating at 650 revolutions per minute. The electrical arrangements differ from those in other electric launches, and give more accommodation for passengers. Her dimensions are as follows:—Length over all, 35 feet; beam, 5 feet 8 inches; depth, 2 feet 3 inches; draught aft, 16 inches; displacement, 3½ tons. She was let to the Thames Conservancy last year to keep the course clear at Henley Regatta, and is the fastest electric launch on the Thames, doing 10 miles an hour. She has no cabin, and somewhat resembles a torpedo boat. The sister boat to her was the *Myionu*, built of steel, for Captain Homfray, of the Horse Guards, and was also designed and moulded by Mr. W. S. Sargeant, who is now laying down at the works at Twickenham four electric launches and two gigs, also a steam launch for passenger service, 70 feet in length with 11 feet beam, fitted with compound surface condensing engines. She will be built of bright teak throughout.

The Electric Light in Deptford.—The adoption of the electric light in the outlying townships and suburbs of London is growing apace. Probably one of the best lighted districts of London from an electrical point of view is that of Brixton. On the occasion of a recent visit to Deptford, however, we were pleased to note that great progress had been made with this method of lighting in that district. Amongst others we noticed that the Old Fountain Hotel, Broadway, was being fitted by Mr. W. A. Easter, of Burchell Road, Peckham.—The premises of Mr. T. H. Parry, tailor, Broadway, are being fitted by Messrs. Wilkins & Co., of Florence Street, New Cross, S.E.—The premises of Messrs. Liptons, in the High Street, have recently been fitted up with the electric light.—The same may be said of the premises of Messrs. Wright and Sons, outfitters; Messrs. Thomas & Sons, funeral undertakers; and Messrs. Bland and Phillips, drapery and furnishing establishment, all in the High Street. —Messrs. Laing, Wharton and Down, of New Bond Street, are also fitting up the premises of Mr. Walter Payne, tobacconist, High Street.

The Electric Light in the West End.—Numerous installations are at present being carried out in the West End. Messrs. Edmundsons, Limited, Great George Street, Westminster, are carrying out an installation at 50, Albemarle Street, Piccadilly, —The Planet Electrical Engineering Company, of Victoria Street, S.W., are preparing the premises of Messrs. Stallard & Co., wine merchants, 4, Albemarle Street, for the electric light.—The contract for fitting up the installation in the handsome pile of buildings now approaching completion in Piccadilly for the Piccadilly Club, has been secured by Messrs. Frank Suter & Co., Berners Street, W.—Messrs. Drake and Gorham, of Victoria Street, S.W., are engaged in fitting up the Westminster Hospital.

Country House Lighting.—Woodhatch, Reigate, the residence of Mr. T. Burt Heywood, is to be lit throughout with electricity, and the contract has been placed with Messrs. Drake and Gorham, who are carrying out the work. The power is to be obtained from a 7-H.P. Otto gas engine, driving an 8-unit dynamo, and arrangements will be made for driving a pump, if it should be necessary, at some future time. This firm is also just completing an installation of 280 lights which they are erecting for Captain Penton, M.P., at Chalfont Park, Slough.

Electric Pumping Plant at North Seaton Colliery.—Messrs. Ernest Scott and Mountain, Limited, have just completed a large electric pumping plant for the North Seaton Colliery to the order of Messrs. G. B. & T. E. Forster. These pumps are the largest electric pumps that have up to the present been made. The pumps, including the generator, were running in the firm's works on Saturday last. They were then working under identically the same conditions that they will be in the colliery.

The Electric Light in Melbourne.—It will be remembered that tenders were recently invited for the establishment of a central station for the electric lighting of Melbourne, Australia. We now learn that the Thomson-Houston International Electric Company have secured the contract for the supply of the necessary plant. The contract for the cables has been secured by the International Okonite Company, Limited, while the contract for the boilers—four in number—has been given to the Babcock and Wilcox Company.

Société Internationale des Electriciens.—Members of this society, of which Mr. R. Aylmer, M.Inst.C.E., is hon. secretary and treasurer in this country, are requested to note that the Society's office, which was formerly at 42, Parliament Street, is now at 47, Victoria Street, S.W., and that the registered telegraph address is "Leclanché, London."

College Electric Lighting.—Mr. Walter Leake, of 30, Victoria Buildings, Manchester, and 35 Dame Street, Dublin, has been appointed consulting electrical engineer to St. Patrick's Training College, Drumcondra, Dublin. It is intended to adopt the electric light throughout the whole of the college premises, an installation of about 350 lights being required.

Tenders accepted—Bristol.—It will be seen from our "Notes" columns that the tenders accepted for the alternators and dynamos and other accessories of the central electric lighting station were as follows:—Siemens Brothers and Company, Limited, alternators and dynamos, £11,691. Tinker Brothers, boilers, £7,732.

Tenders Wanted—Roumania.—The Minister of the Posts and Telegraphs of Roumania, at Bucharest, is inviting tenders for 1 ton of galvanised iron wire of 1·8 mm. diameter; 2½ tons ditto of 3 mm. diameter; 5 tons ditto of 4 mm. diameter; and 10 tons ditto of 5 mm. diameter. Tenders are also invited for the supply of 10,000 large porcelain insulators and 20,000 small ditto.

Indo-European Telegraph Company.—The company's branch station at East India Avenue, Leadenhall Street, E.C., has been removed to 6 and 8, Lime Street Square, E.C., where it is connected by special wire with the company's chief office at 18, Old Broad Street.

Sales.—Messrs. Wheatley Kirk, Price and Goulty, as will be seen from our advertisement columns, have a small electric light installation for sale. The same firm have also a number of engines, boilers, and dynamos for disposal. Full particulars of these will be found in our advertisement pages.

Lacombe and Company.—In order to meet the further development of Messrs. Lacombe & Co.'s business, a limited company has been formed to take over their works and plant at Levallois-Perret, near Paris.

CITY NOTES.

The Western Counties and South Wales Telephone Company, Limited.

ON Tuesday afternoon an extraordinary general meeting of the above company was held at Bristol to consider resolutions for the amalgamation of the company with the National Telephone Company, Limited. Mr. C. Nash, chairman of directors, presided, over a large attendance of shareholders.

Mr. H. F. LEWIS (general manager and secretary) read the convening notice.

The CHAIRMAN moved—

"That the agreement submitted to this meeting, and expressed to be made between this company and the National Telephone Company, Limited, for the amalgamation of the two companies by a transfer of the business and property of this company (with certain exceptions) to the National Telephone Company, Limited, be, and the same is, hereby approved."

One reason, he said, why it was most important that the company should be united to the National was, that they might have joint

action. Joint action was desirable, among other things, in dealing with the Post Office, and in connection with the extensive changes that were now being introduced in telephone matters. They were on the eve, probably, of a revolution in telephone work. The directors had made the best terms they could with the National, and they were unanimously of opinion that the shareholders would be doing right in confirming the provisional arrangement which had been made, and in this they were glad to know the great bulk of the shareholders agreed. It had been pointed out that 6 per cent., which was the dividend now payable on the National Company's stock, would yield £1 13s. 4d. per cent. upon their company's shares if the proposed arrangement were carried out. This was more than they had paid up to the present time, and it was certainly more than they could expect to earn if the company went on independently. He reiterated that it was more than they could expect to earn if the companies continued independently.

Mr. MARK WHITWILL seconded the resolution.

Mr. GEORGE WHITE referred to the letter which members of the Bristol Stock Exchange addressed to the directors, expressing their opinion that there was no reason why the undertaking should be sold except upon proper terms. After lengthy remarks, he moved the adjournment of the meeting for three weeks, to enable the directors to further consider their position.

Mr. MCKNIGHT (Liverpool) seconded the amendment, and expressed the opinion that before any terms were discussed with the National Company, ordinary shareholders ought to have had the option of finding the money necessary to carry on the business.

Mr. J. G. STROUD supported the amendment.

Mr. JAMES INSKIP, the company's solicitor, referred to the agreement in existence between the two companies, and said that it contained a provision not only that the company should not enter into an arrangement with the Post Office, or any public department of the Government, without the sanction of the National Company, but, further, that whatever compensation was received should be divided between the companies in such a manner as arbitrators should settle. In other cases the amalgamations had been with large companies—not, as some shareholders might think, with small ones. This matter had not been rushed; the directors had been attending to it for a long time.

Mr. R. CORY (Cardiff), one of the directors, defended the action of the board.

Replying to a question,

The GENERAL MANAGER said that nothing less than £100,000 or £150,000 would be of use to the company, considering its future prospects.

The amendment was carried by a large majority, on a show of hands.

Mr. INSKIP (to the chairman): You must have the proceedings regular; there are some gentlemen who are not entitled to vote, and the only thing you can do is to take a poll.

The CHAIRMAN, after a brief consultation with other directors, said he thought they must take a poll. They could not ignore the fact that a large number of shareholders had expressed their approval of the course the directors had taken, and although a good many hands had been held up for the amendment that afternoon, they represented a comparatively small amount of capital.

Mr. INSKIP added that unless the matters were completed by the 1st of August, the agreement would fall to the ground. Therefore Mr. White's motion of adjournment, although in that form, was something like a motion in the House of Commons to adjourn a Bill for six months. It was equivalent to upsetting the entire proposal, and therefore it appeared to him that the chairman was quite in order in taking a poll.

Mr. WHITE said he had intended asking the directors to receive a certain number of shareholders to discuss various questions during the period of adjournment.

The directors consulted in private for a few minutes. On their return,

Mr. INSKIP communicated the decision, which was that the chairman should take a poll at once upon the motion for adjournment. He saw no reason why the chairman should not forthwith take the poll, and assuming that it disposed of the motion for adjournment, he understood the directors would not seek that day to conclude the resolutions for confirming the agreement, but that they would keep the poll open for a reasonable time to give the shareholders an opportunity of voting.

Mr. WHITE said he should test the legality of that course, and he suggested that those who supported him should leave the meeting with him.

These gentlemen having withdrawn, a poll was taken, and the motion for adjournment was declared lost, 87,285 votes being recorded against it.

Mr. INSKIP said the gentlemen who had withdrawn represented about 3,000 shares.

A resolution was unanimously adopted for the winding up of the company voluntarily, Mr. T. A. Welton, of London, being appointed liquidator, and authorised to carry the agreement into effect, to receive the shares agreed to be allotted, with the cash payable thereunder, and to distribute the same among the members of the company.

A vote of thanks to the chairman for presiding concluded the meeting.

The West Coast of America Telegraph Company, Limited.

THE directors report that the gross income of the company for the year ending December 31st, 1891, as shown in the balance-sheet and revenue account, was £35,624 16s. 5d., against £65,323 15s. 4d. for the year ending December 31st, 1890. Adding £2,195 12s. 11d. brought forward from the previous year makes a total of £37,820 9s. 4d., and deducting from this the debenture interest and all other charges, there remains the sum of £1,413 9s. 9d. to be carried forward. During the revolution in Chili, four sections of the company's cables, extending from Mollendo to Caldera, were cut by the Chilian war vessels; these cables were repaired after about two months' interruption. The southern section, Valparaiso to Serena, was closed for public traffic by order of the Government for nearly six months, and it was not until September 1st last that communication was completely restored over the company's system. The negotiations mentioned in the last report have been brought to a satisfactory termination, and a land line is already in course of construction between Buenos Ayres and Valparaiso, which will connect the company's system with those of the Western and Brazilian, the Brazilian Submarine, and the Eastern Telegraph Companies, and thus meet the competition of the Central and South American Telegraph Company. The directors extremely regret the death, on February 19th last, of their late esteemed chairman, Mr. Alfred Marshall, by whom the above negotiations had, up to that date, been chiefly conducted on behalf of the company. Sir John Pender, K.C.M.G., who has taken active part in bringing about the arrangement above alluded to, will, it is understood, continue to give his valuable support as chairman of the new connecting company. Mr. J. Denison Pender, a director of the Brazilian Submarine and other telegraph companies, has kindly consented to join the board and to occupy the chair of the company, and will accordingly be proposed for election at the general meeting of the shareholders now called. This accession of strength and the amicable working arrangements with the Brazilian companies open up a fair prospect for the future of the West Coast Company. Mr. Henry Roberts and Mr. Frederick Walters are the directors retiring by rotation; both are eligible and offer themselves for re-election. The auditor, Mr. J. Weise, of the firm of Messrs. Turquand, Youngs, Weise, Bishop & Clarke, retires, but in consequence of the uncertainty of his health, does not seek re-election. Mr. John Francis Clarke, however, a member of the same firm, offers himself to the shareholders for election.

The following is a list of the cables and land lines belonging to the company:—

				Nautical miles.
CABLES.	Valparaiso	to	Serena	219·03
	Serena	„	Caldera	215·34
	Caldera	„	Antofagasta ...	229·00
	Antofagasta	„	Iquique	250·50
	Iquique	„	Arica	128·35
	Arica	„	Mollendo... ...	146·42
	Mollendo	„	Chorrillos ...	510·08
LAND LINES.	Chorrillos	„	Lima	11·00
	Lima	„	Callao	7·00
	Valparaiso	„	Santiago	106·00
				1,822·72

St. James's and Pall Mall Electric Company.—A meeting of the holders of founders' shares in this company was held on Wednesday last at Winchester House. Our representative was refused admission, the proceedings being private.

The following notice appeared in Wednesday's *Financial Times* regarding this meeting:—"With reference to the circular issued to the founders' shareholders, and signed by Messrs. Fry, Sturdy, Kitchin and Francis, the directors of this company state that the proposed meeting has been called without consultation with them, and that the statements in the circular are *ex parte* and must be taken as such."

Eastbourne Electric Lighting Company, Limited.—In sketching the history of electric lighting in Eastbourne, at the meeting of the Eastbourne Electric Light Company held last Monday, the chairman (Alderman G. Boulton) mentioned that the earnings of the company in 1886 to September were £679, in 1887 £2,263, in 1888 £3,529, in 1889 £4,053, and in 1890 £4,539. The company proposed to reduce the price from 10d. to 9d. per unit. The report of the year's working, which was considered very satisfactory, was adopted.

The Eastern and South African Telegraph Company.—The directors of this company notify that the coupons due July 1st next on their 5 per cent. mortgage debentures will be paid on and after that date, at the banking house of Messrs. Barclay, Bevan and Co., 54, Lombard Street, E.C. Coupons should be left at the bank three clear days for examination.

The Vaughan-Sherrin Electrical Engineering Company, Limited.—At meetings of this company, held on May 19th and June 10th, it was resolved that the company be wound up voluntarily. Septimus Hedges, of 15, George Street, Mansion House, E.C., was appointed liquidator for the purposes of such winding up.

National Telephone Company, Limited.—The directors have resolved to recommend dividends for the last half-year at the rate of 6 per cent. per annum on the preference shares; and 7 per cent. per annum on the ordinary shares.

TRAFFIC RECEIPTS.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending June 17th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company Limited, amounted to £2,578.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, June 16th.	Closing Quotation, June 23rd.	Business done during week ending June 23rd, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	101 —104	101 —104	...	...
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	48	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	87½ — 88½	87½ — 88½	88½	88
2,849,510*l*	Do. do. Deferred	Stock	10¾ — 11¼	10¾ — 11¼	11¼	10 3/16
130,000	Brazilian Submarine Telegraph, Limited	10	10¼ — 10⅜	10¼ — 10⅜	10⅜	10⅜
53,200*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	102	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	105 —109	105 —109	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅞ — 3¼	2⅞ — 3¼	3 1/16	2⅞
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2 — 2¼	2 — 2¼	2	...
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3½ — 4½	3½ — 4½	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½ — 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152, £4 paid	10	9¾ — 10¼	10¼ — 10¾	10½	10 3/16
$7,716,000	Commercial Cable, Capital Stock	$100	155 —160xd	155 —160xd	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	⅛ — ¼xd	⅛ — ¼xd	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5¼ — 5⅝	5½ — 6	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	16½ — 17½	16½ — 17½	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜	3¼ — 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	11½ — 11⅝	11½ — 11⅝	11 1/16	11¼
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅝ — 15	14⅝ — 15	14 5/16	14⅝
70,000	Do. 6 p. c. Preference	10	15¼ — 15⅝	15¼ — 15⅝	...	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 —110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	108 —111	108 —111	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	15 1/16
78,300*l*	{ Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326 }	100	103 —106	103 —106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	{ Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343 }	100	102 —105	102 —105	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	101 —104	102 —105	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	5¼ — 6	5¼ — 5⅝	5⅝	5⅜
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ...	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	1⅛ — 1⅜	1⅛ — 1⅜	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜ — 2⅝	2⅜ — 2⅝	2⅛	2⅜
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1⅜ — 1⅝	1 — 1⅛	1⅜	1 1/16
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	10⅛ — 10½	10⅛ — 10⅜	10⅜	10 3/16
180,042	Do. do. 6 p. c. Preference	10	15⅛ — 15⅜	15⅛ — 15⅜	15⅛	15⅛
150,000	Great Northern Tel. Company of Copenhagen	10	18¾ — 19¼	18¾ — 19¼	19	18¾
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	106 —109	106 —109	...	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	7½ — 8¼	7½ — 8¼	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10¼xd	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	19½ — 20½	20 — 21	20½	20¼
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	40 — 42	40 — 42	41½	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	3½ — 4½	3½ — 4½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	8 — 9	8 — 9	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16 — 3 9/16	3 7/16 — 3 9/16	3½	3½
10,000	Do. do. fully paid	5	5 1/16 — 5 3/16	5 1/16 — 5 3/16	5⅛	4⅞
38,348	London Platino-Brasilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	7¼ — 7⅝	6⅞ — 7¼	7	6 15/16
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅞ — 5	4⅞ — 5⅛	5 1/16	4⅞
15,000	Do. 6 p. c. Cum., 1st Preference	10	13¼ — 13⅜	13¼ — 13⅜	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½ — 13	12½ — 13	...	...
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	108 —110	109 —111	110	109
250,000*l*	Do. (issued at 5 p.m., all paid)	...	104 —106	105 —108	...	...
6,318	Notting Hill Electric Lighting Company, Limited, £8 paid ...	10	4 — 5	4 — 5	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	5/16 — 7/16	5/16 — 7/16	...	...
9,000	Reuter's Limited	8	6½ — 7½xd	6½ — 7½xd	7½	7⅛
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	8½ — 9	8½ — 8⅝	...	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	7¾ — 8¼	7¾ — 8¼	...	...
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	...	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½ — 4	3½ — 3⅝	3⅝	...
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46	44 — 46	46	45
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1½ — 2½	1½ — 2½	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	7 — 8	7 — 8	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	99 —102	99 —102	...	...
30,000	West Coast of America Telegraph, Limited	10	3½ — 4½	3½ — 4½	3⅝	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	104 —108	104 —108	...	...
67,007	Western and Brazilian Telegraph, Limited	15	9¼ — 9⅜	8¾ — 9¼	9⅛	9
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6 — 6½	6 — 6½	6 3/16	6⅛
30,364	Do. do. do. 5 p. c. Deferred	7½	3 — 3½	2⅜ — 3¼	3⅛	2⅜
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	105 —108	105 —108	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	105 —108	105 —108	106½	...
88,321	West India and Panama Telegraph, Limited	10	1¼ — 1⅜	1¼ — 1⅜	...	...
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¾ — 10¼	9½ — 10	...	...
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	8¾	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	104 —108	105 —109	...	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	118 —122	118 —122	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —103	100 —103	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	6¼ — 6⅜	6¼ — 6⅜	6½	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3½.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7½.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅞—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5¾—6.—Liverpool Electric Supply Shares of £5 (fully paid), 5 1/16—5⅛.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Founders' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid), 10—⅛.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—⅛.—Do. Debentures, 103—⅛.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ⅛—¼.—£5 Preference (£2 10s. paid), 2⅛—3.—Ward's Electric Car (£10 paid), 1⅛—1⅜.

BANK RATE OF DISCOUNT,—2 per cent. (April 28th, 1892).

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

AN ordinary general meeting of the Institution was held at the Institution of Civil Engineers, 25, Great George Street, Westminster, on Thursday, May 19th, Prof. W. E. Ayrton, F.R.S., President, in the chair.

Dr. J. H. GLADSTONE resumed the reading of the paper by himself and Mr. Walter Hibbert on "The Cause of the Change of Electromotive Force in Secondary Batteries."

DISCUSSION.

Mr. G. H. ROBERTSON read a joint contribution by Prof. Armstrong and himself, who considered that the authors of the paper had failed to make out their case. He accepted their results as experimentally correct, but did not agree with the interpretation they placed on them. The authors claimed that the variation of the electromotive force of a battery was due to changes in the strength of the acid. They did not deny that peroxides occurred, but claimed that these had little if any effect. It was well known that the acid cooled during discharge, and it seemed difficult to explain this in any other way than by dissociation of the acid from the water, the lead sulphate being formed by free molecules of H_2SO_4 and not by the dilute acid. The amount of peroxide present in a cell at any moment was no criterion of the total amount formed, as these compounds were very unstable, and, as a fact, oxygen was liberated from the cells under certain conditions. In the method of experimenting adopted by the authors no precautions were taken to free a plate from peroxide from a stronger solution, before placing it in a weaker one, and their results were thus vitiated. The electromotive forces observed when plates of peroxide were placed in acids of different strengths he believed to be due to the fact that these plates had supports of metallic lead, in which case the stronger acid would have more action on this lead than the weaker acid would. In short, he believed that the results obtained by Dr. Gladstone and his colleague were not inconsistent with the theory advanced by himself and Mr. Robertson in a communication to the Royal Society, that the efficiency of the cell, viz., was greatly affected by the presence of peroxides in the electrolyte.

Mr. CROMPTON: Dr. Gladstone's paper is a contribution to the science of this subject of the highest possible importance. There is no doubt that he has touched upon certain points which we knew of before, but which we have not worked out quantitatively in the manner he has worked them out in the paper. So well was the effect of the electrolyte being of varying strength at different periods of discharge and at different parts of the cell known to Mr. Howell and myself six years ago, that we actually took out a patent to introduce artificial means for circulation to counteract its effect, and in order to equalise the strength of the acid throughout the cell. Although we found the use of artificial agitation to produce this effect was hardly practicable, we did then note the effect which has been touched upon in this paper, and which has been of very considerable service in the use of accumulators, and that is the effect which is touched on on page 10, where a table is given of the resistance of sulphuric acid cells. That 30 per cent. answers, I believe, to the figure we obtained of 1,245 to 1,260 specific gravity when the resistance of the electrolyte is at a minimum. We utilised that effect in order to make the electrolyte self-regulating as regards its density. If you draw that table in the form of a curve you will see that point 30, which answers to 1,240 to 1,260 in gravity, is at the bottom of the curve, which slopes upwards in both directions. It is evident that any increase or decrease of specific gravity will have the same effect of increasing the resistance of the electrolyte, and a little thought will show that that property of the acid is of the highest importance, as any change in specific gravity will have the tendency of producing the effect of decreasing or increasing the action at that particular point. I, and those working with me, have attempted to do a considerable amount of work, of quantitative work, in connection with accumulators; but I must say, although we hail the results obtained by such workers as Dr. Gladstone, Prof. Ayrton, Mr. Robertson and others, as of the greatest interest to us, yet we look on those results with a certain amount of suspicion. I fully admit that Dr. Gladstone has done a great deal to prove his case, but still the actions in an accumulator cell are so very complicated and so very difficult to follow that I should hesitate to accept these facts as proved until they had stood the test of a much longer series of experiments and under wider conditions than those detailed in the paper. I know that many results we appeared to arrive at after experiments on small cells, have been absolutely contradicted by subsequent experiments with bigger plates and larger cells. For that reason I am one of those who believe that no quantitative experiments are of the least value until they have extended over some years, and that is the reason why we have steadily gone on with it for six or seven years, and I believe that is the reason why we have obtained results in some sense satisfactory. Mr. Clauss, Mr. Howell and myself have been for six or seven years at this job. Our first idea was to determine this question as to the equalisation of the strength of acid which we know so greatly affected the E.M.F. We could not introduce any means of artificial agitation, and it therefore became necessary to so proportion the spaces between the plates, that we gave the greatest freedom to circulation. After very long quantitative experiments, we have arrived at a figure of something like between 65 and 70 per cent. of the total space occupied by plates and electrolyte together, must be occupied by the electrolyte outside the plates. That does not take into consideration the electrolyte that has soaked into the porous interstices of the plates themselves. The next point to determine was to what degree of porosity we could allow our plates to be made, so that we might get each individual crystal or molecule, of which the plate is composed, to be freely bathed by the electrolyte; and this has been the longest job of all. It is evident, as you increase the porosity, as you increase the largeness of the crystals, so do you weaken them mechanically; they are more likely to be broken by mechanical concussion. But the fact does remain that the weaker the plates are mechanically up to a certain point, the stronger they are chemically. The fact is that they can then, these very porous plates, made of such large crystals, have these crystals freely bathed by the electrolyte; in other words, a much freer circulation through them than through the plates of a condenser, tends so greatly to the increase of the life of the plates, that we have arrived at the remarkable results you know of in the Howell form of accumulator. After many years we have fixed on a size of crystal which has given fairly good results. We have long known of the increase of E.M.F. due to the increase of the strength of the electrolyte, and we have long used an electrolyte stronger than other people, but this is so little known by the world generally that at a recent trial a great many scientific witnesses would not believe that a cell which was giving 2·08 volts was in practice nearly fully charged, whereas we knew that that was the case. It was evident that those gentlemen had no knowledge of the fact that 2·08 volts was the proper strength for a cell on open circuit; even when very nearly discharged it will remount to 2·08 if the strength of the electrolyte be between 1,240 and 1,250. The whole of my experiments have been carried out with one form of cell; that is to say, cells consisting of plates formed originally from pure lead crystals which have been formed electrically into peroxide plates and spongy lead. Our spongy lead is very spongy on the negative side, and it was of great importance to us to know at what strength of electrolyte these delicate crystals of spongy lead would be attacked by the electrolyte itself. With regard to that question, if observations were taken at ordinary temperatures, that is under 75° Fah., we found that the electrolyte reached 1,250 or 1,260. It was very important for us to obtain this knowledge; and that is the figure we arrived at. There is one fact I should like Dr. Gladstone to notice in his reply; he has not touched upon it in the paper. I wonder if he will be able to account for the very curious fact that in all the cells I have experimented with there is always a slight rise of E.M.F. after the first rapid fall shortly after the commencement of discharge. First, there is a very rapid fall, say from 2·08 down to 2·01, and then it will rise again to 2·02, almost to 2·03, and gradually fall again, and it is very difficult to account for that rise. It may be possible to account for it by a redistribution of the strengths of the electrolyte to the plates, but I must say I have not been able to do it during the time I have been sitting here to-day. The paper is full of valuable matter which really has to be worked over in the laboratory; the experiments have to be followed out a second time, and I fully intend to do that, and I hope to discuss this subject at a future meeting, either when Dr. Gladstone favours us with a further paper, or we ourselves may bring up a paper on the subject; but this is one of those papers which are distinctly valuable to the Institution from every point of view. I wish to call attention to a foreign contribution to this subject which those of you who have not read it ought to read That is a paper contributed to the *Elektrotechnische Zeitschrift* of January 8th of this year by Dr. Krügel, in which he points out the cause of that bugbear of all accumulator users, the self-discharge of negative plates under certain conditions, and I think he has proved his case in attributing it entirely to metallic impurities originally present in the electrolyte. The reason why this effect has eluded all us English observers so long is, that we have never attempted to take out an electrolyte to test for these impurities at the right time. As a matter of fact, up to a very late period of the discharge the greater proportion of those impurities still remain on the lead plate, and it is only at a particular moment, almost the moment of reversal, that you get them in solution, and are able to detect them, and I believe that is the reason why we have failed to notice them. There is no doubt that Dr. Krügel's experiments were of a very practical nature, as they extended over an enormous number of batteries belonging to the Tudor Company of Germany, and they have a great value. That self discharge is half the trouble we have to deal with in accumulators. For many years we could not make out why so many cells in a battery were what we called sick. You started with what you thought was a full battery, and found a certain number in perfect order, but that a certain number had hardly any capacity, and were immediately reversed by the action of the other cells with very disastrous results to the positive plates. In that case the real offender is the self-discharge of those negative plates. This has never been shown before, and I think great credit is due to German physicists for having shown us the cause of this difficulty.

Mr. SMITH: This nice, simple theory, that Dr. Gladstone has put forward, has such a fascination that one does not like to differ from it. But when the authors themselves start by taking certain modifications produced by the alteration in density, we can go a little further. The first point I wish to call attention to is this: In our Edinburgh paper we called attention to the fact that in rest the potential difference rises when you commence a discharge. Not only does it rise the first time you complete the discharge, but charging up again you get the same effect to a lesser extent. Another point is the decay of the positive grid. That, I think, is not due to the formation of that sub-sulphate that Dr. Gladstone mentions, but you must look for the cause of it to the negative plate. The effect of rest we showed was the same as if you removed part of the lead plate out of the battery, and so diminished the capacity through the lead plate sulphating owing to local action. Now in practice you get rid of that sulphating; one has to overcharge the cells considerably, and continually, and this continual overcharge of the positive plate bites further and further into the grid, and forms in the grid the Planté effect. If, as Dr. Gladstone points out, there is a considerable amount of local action on the positive grid at

the end of charge during rest, should there not be a great deal more during the charge itself when the sulphuric acid is of great density there and is forming a short-circuited battery? Another point. They say: "The rate of weakening of the acid is therefore a constantly increasing one, and may finally become so rapid that the acid strength of the liquid against the working surfaces of the plates is very low or about nil. In such a case we may expect the formation of a substance which gives the analysis which follows. Now, if you force the discharge beyond this point continually, charge after charge, you get a certain amount at the bottom of the cells. One would expect from what the authors say, that matter to consist of this. It does not. It gives an analysis which would be accounted for by a formula thus: PbO_2 Pb SO_4, one molecule of peroxide and one molecule of ordinary sulphate. Funnily enough, this very nearly agrees with the analysis of discharge of the positive plate, and that in itself will account for the fact that we have to use a much larger positive plate than one would think, that when the positive plate is discharged to this formula, then the peroxide will no longer hold together, but will drop out of the plates. Next, local action takes place at the end of a discharge, when the acid is weak, much more rapidly than at the end of a charge, when the acid is strong, and takes place at a different point. Local action at the end of a discharge, if you allow rest whilst discharging, the effect is to increase the time of the next charge. Allowing the rest charging the effect is to diminish the capacity. Dr. Gladstone mentions the fact that on trying to calculate the E.M.F. from thermo-chemical data he did not get results which agreed with his experiments. Now, we showed, and Prof. Duncan also showed, that there was a distinct cooling of the cell during discharge—we cannot account for it—as if the energy required to separate the sulphuric acid from the solution was derived from the outside as heat. Now, if that is so, Dr. Gladstone should find by experiment an E.M.F. somewhat higher than by calculations. I do not know if that is the case.

Mr. J. SWINBURNE: It is a little bit discouraging to talk about secondary batteries in such close proximity to Mr. Mordey. A little while ago he told us the great advantage of alternating currents was that you could not put secondary batteries on them; now he has come to the conclusion that the worst thing about secondary batteries is, that you cannot be sure of getting them always equally bad. Referring to Dr. Gladstone's theory that the variations of E.M.F. are due to the liberated acid in the coatings, I would like to say, as a matter of personal justice to myself, that the variation of E.M.F. due to that cause was pointed out by me in 1883 in a little book on electrical units. Referring to temperature coefficient, I cannot help thinking there is a little confusion about what Dr. Gladstone calls the Thomson law. Sir William Thomson's—Lord Kelvin's—law that the E.M.F. ought to be got directly from thermo-chemical data is wrong. It was pointed out by Helmholtz in 1882 that there was a second term, the temperature coefficient to be considered. The particular case taken by Sir William Thomson, the Daniell cell, has no temperature coefficient. Without you have the temperature coefficient you cannot calculate; you must know the temperature coefficient as well as the E.M.F. of that cell. It was pointed out by me theoretically that a secondary battery ought to cool on discharge, and I think Messrs. Ayrton, Lamb and Smith, found out that it did so very shortly afterwards. Mr Crompton referred to the curious rise on discharge. I understand he first got a sudden fall, then a slight rise, and then a fall. I suggest the sudden fall is due either to the acid or to Messrs. Robertson and Armstrong's per-sulphuric acid or hydrated oxide. But I will get out of that for a moment. Then you come to the time when the resistance of the cell is altering, and I believe the rise is due to the resistance of the cell falling and not to the E.M.F. increasing.

Mr. CROMPTON: A rise of E.M.F., not of currrent.

Mr. SWINBURNE: But a rise of E.M.F. while taking current. I think that would be due to fall of resistance. I do not want to go into personal matters too much, but the question of self-discharge was brought before the Society by me in 1886, when I pointed out that the least impurities in the acids, anything that could settle on lead would settle on lead, and would give rise to local action. I think Mr. Crompton overlooked that. At one time I thought I was an authority on secondary batteries; now I know I am not. Mr. Crompton has told me so. I do not want to tell tales out of school; but a little while ago I was electrician to Mr. Crompton's firm. Mr. Crompton gave me a Crompton-Howell battery to test.

Mr. CROMPTON: That was six years ago.

Mr. SWINBURNE: I tried to find some efficiency in that battery, and I could not find even what a chemist would call a trace of efficiency. One day Mr. Crompton came into my office to ask about the test. I told him the sad results of my experiments. He went out sadly; but before going, he said: "Swinburne, you are a good fellow, and I don't want to say anything to hurt your feelings, but you know as little about batteries as Ayrton!"

Mr. CROMPTON. That was six years ago.

Mr. W. HIBBERT: In the paper, the section which deals with the relation of thermo-chemical values, and the E.M.Fs. that correspond to them, is avowedly and professedly abbreviated. It is said that the matter will be postponed for further consideration. But there are two points in which it is shown that the calculated values agree with the observed ones very well. At the top of the curve—that is to say, when the plates are in pure H_2SO_4—the calculated value is something like 2·602 volts, whilst the observed is 2·607, a discrepancy between them of something like one-fifth of a volt; and considering the difficulty of getting plates really in contact with the strength of acid supposed to be there, that was an extremely good agreement. It was for that reason, because of the statedly imperfect nature of the consideration, that no reference was made to the experiments of Duncan and Wiegand, but they were not overlooked, and the hypothetical conclusion that the discrepancy between observed and calculated values at other points than beginning and end would lead to other results was quite right. At intermediate points the observed values should be, roughly speaking, something like $\frac{1}{10}$th of a volt higher than the calculated ones, and it may be that the freezing mixture property, as Mr. Swinburne would call it—the property of cooling—may in part account for that, but there are many other physical actions necessarily occurring. All that was rather reserved for further consideration, so that the criticisms levelled against that may possibly be robbed of a good deal of their force. With reference, however, to the remarks read by Mr. Robertson, a good many suggestions and fancies are mentioned in that paper, but unfortunately the effective experiment, as we carried it out, was directly against them. We tried the effect of adding hydrogen oxide to the cell and found no effect worth noting, nothing that could be dwelt upon; the change of E.M.F. on adding a fair amount of hydrogen oxide was almost negligible, and did not reduce the strength of the acid to the requisite degree. He also tried adding per-sulphate of potassium, which ought to have given us per-sulphuric acid, but in no case were these substances adequate to produce the large changes of E.M.F. found here. It is not merely when sulphuric acid produces these large changes in E.M.F. that the range of change covers the working ranges observed by nearly all observers. The form of curve as you carry it down from strong acid to a very weak one is not unlike the discharge curve observed in the paper by Prof. Ayrton and his colleagues. Consequently the effect is brought into agreement with the changes of potential difference in that long paper given by us two years ago. Mr. Crompton, in speaking of these experiments having been made with small cells, suggested that therefore they might be liable to suspicion. But the paper is exclusively dealing with E.M.F., and in no case does E.M.F. pure and simple depend on the size of the cell. So long as we are dealing exclusively with E.M.F., it seems to me the size of the cell is of hardly of any importance. Mr. Swinburne mentions Thomson's law as being incomplete, as one term only is taken into account, and said that Helmholtz showed there should be a second. That is true. But Preece showed in 1883 that the temperature co-efficient, which is the second term of Helmholtz, of an accumulator is very exceedingly small, I think even smaller than a Daniell. Such a term, therefore, would be practically negligible.

The PRESIDENT: In connection with what Mr. Swinburne was saying, it is exceedingly important to distinguish between the E.M.F. of the cell and potential difference at the terminals. When Mr. Crompton said the E.M.F. rose soon after the commencement of discharge of his cell, did he not really mean that the potential difference at the terminal rose?

Mr. CROMPTON: Yes.

The PRESIDENT: Because that very likely would be explained, as Mr. Swinburne showed in his paper two years ago, both in charging and discharging the cell the resistance first falls. During the first hour there is a distinct fall of the resistance of a cell, both in charging and discharging. Afterwards there is a very considerable increase of resistance both in charging and discharging. Mr. Crompton tells us to-night he has observed a rise in the potential difference soon after the beginning of the discharge. I may mention in some recent tests I have been making, not yet published, of a new kind of cell, I find the same sort of thing after charging. This hump that we have observed in charging, and the similar hump which I understand Mr. Crompton has observed in discharging, in consequence of the fall of resistance in beginning of charge and discharge, is more noticeable when you are charging or discharging with large current. The reason why in these curves published in this paper there is no such hump seen, although this fall of resistance is shown, is probably because, with the E.P.S. type of cell, you are only allowed to discharge with rather small current density. But in the non-pasted plates I have been speaking of you may discharge with such a large current density that a very small change of resistance makes a very considerable potential difference.

Dr. GLADSTONE: I think my first duty is to say how grateful I am to the society for the way in which it has received this communication both last week and this week. Of course we come before those who are constantly working with these secondary batteries, and although I have had a very large amount of experience with them, but we could not tell how much this matter would be known in any respect, or how far our conclusions would commend themselves to those before whom we brought them. I myself have looked at the matter mainly from the chemical side, and concluded what must be the electrical result considering the chemical changes which were taking place there. Well, I am very glad indeed to hear that this theory of ours has been so distinctly recognised by several experimenters before. Of course everyone knows that the E.M.F. of a battery does vary along with the strength of the sulphuric acid to a certain extent, but I think from many things I have heard quite recently this is not very universally recognised, at any rate that the correlation between one and the other is not very generally known. It was known to Mr. Swinburne, Mr. Crompton, and others, but the fact is, a true fact is never all at once brought forward, and accepted immediately, but finds its way gradually into general acceptance. This is finding its way amongst electricians now. With regard to the importance of promoting diffusion, I was glad to hear the remarks of Mr. Crompton, and that his attention has been directed to that matter so practically before ever it occurred to us to mention it at the end of our paper, and also the confirmation he gives in regard to the connection between the amount of E.M.F. and the strength of acid, that it is pretty well what is shown in the diagram. As to the chemical changes that take place, I do not think there can be much doubt whatever as to the formula I put down on the board in both directions as to the ultimate results. There may be a great deal of difference as to whether there are any intermediate reactions taking place in that formula. Into that matter we have not gone. It is quite possible that that which Mr. Robertson put on the board may exist. These are matters of speculation,

and it is one of the most difficult things in the world to tell what any intermediate stage in the chemical reaction is. We know where we begin and we know where we end, but of the intermediate stage we know nothing. It is very difficult to work out, because in this case we have the ultimate sulphate of lead mixed up with other substances, peroxide of lead and various other things. That is a matter which of course is very interesting. Then it is not for us to say at present exactly whether it is the absolute sulphuric acid, H_2SO_4, that is acting in these batteries, or whether it is the hydrates of sulphuric acid. The result comes to very much the same thing by the thermo-electric calculations. I have nothing to add in regard to the thermo-chemistry to the remarks already made. We propose to work it out more fully, and shall see whether we can do that in the future. As to the presence of the peroxides, and as to the difference of opinion and difference of results of experiments between Professor Armstrong and Mr. Robertson and ourselves, I am at a disadvantage rather, because Mr. Robertson knows all about our experiments and I do not know the experiments which he has performed. At present we only know some of the results of those, and we cannot repeat his experiments because we do not know how to do so exactly in the form which they assumed. I do hope that, as in many of these kinds of investigation, we shall find that there is a certain amount of truth on both sides. Then, of course, there comes to be combinations found and the two work together in some kind of way. I have no doubt whatever these peroxides do make some kind of change of the E.M.F. But all we say is we cannot find any very definite amount of it. No doubt they explain certain phenomena just as well as our explanation does. I did think, coming to our observations and getting such comparatively accurate results from a number of different directions, and such a number of different arguments to bear on the one conclusion, that we must attach a very large amount of importance to the strength of sulphuric acid against the working surfaces of these plates when we consider as to the variation of the E.M.F. The many remarks made will receive our very best attention, and I trust in one way or another, we shall be able to throw a good deal more light on this very obscure subject.

LONDON COUNTY COUNCIL.

THE report of the Highways Committee, presented on Tuesday, contained the following matters:—

Victoria Embankment—Lighting.

Our attention has been directed to the defective lighting of the Victoria Embankment, and especially of the carriage way, and for some time past we have had under consideration the desirability of substituting electricity for gas as the illuminant. In connection with this substitution, the first question that presents itself is what method should be adopted to provide the supply of electrical energy; and three courses appear to be open for adoption, viz., (*a*) to obtain the supply from the companies authorised to supply within the areas in which the Embankment is situated; (*b*) for the council to lay the mains and provide and fix the lamps, and then to obtain the supply from one of the companies; and (*c*) for the council to instal the necessary plant on its own land, and to light the Embankment by means of an independent installation. The first course (*a*) is open to the objection that three several companies would have to be dealt with, the City of London, the Metropolitan, and either the London or the Electricity Supply Corporation, and considerable complication might arise, as one part of the Embankment might be efficiently supplied, while others might not; and, moreover, as each company would have to lay mains for the portion within its own district, the cost might be increased. The second course (*b*) is open to the objection that although the council would provide the mains, and would not, apparently, be prohibited from carrying the current from one company's district to another, the other companies might consider that this course, although probably legal, was straining the strict interpretation of the Acts. The third course (*c*) appears to us to be the proper one for the council to take, having regard to all the circumstances. The first capital expenditure would, of course, be greater, but the cost of maintenance would probably be less, and the adoption of this course would accord with the principle which has been affirmed by the council, of the carrying out of work by its own staff when practicable. Should the council decide to adopt the electric light as the illuminant for the Embankment, we propose that lamps of from 1,000 to 1,200 candle-power should be placed in the centre of the road at about 50 yards from each other. About 50 of these lamps would be required for the carriageway, some few of which at important points might be of a higher illuminating power; and the supply of the electric light might also be extended to the existing lamps on the parapet walls, and, where necessary, to those on the footways. The generating power required for this installation might conveniently be placed upon the land belonging to the council under the Charing Cross Railway bridge; and for the purpose of insuring against the extinction of the light through the failure of any part of the machinery, and also as an economical precaution, the light should be placed on two independent circuits, an engine and dynamo being provided for each circuit, and a third engine with dynamo being kept in reserve to be available, if required, for either circuit. Steam could be supplied by a boiler of the locomotive type, and a second boiler should be kept in reserve for use if required. The mains could be so arranged that at midnight, or at any other time that might be fixed for the purpose, the lamps on one circuit could be extinguished, leaving the Embankment less brilliantly but yet sufficiently lighted. Upon the question of cost, we are advised that the capital expenditure, if the above arrangement were adopted, would probably not exceed £10,000, while the cost of maintenance, including depreciation, repair, and interest on capital, and also providing amply for labour, would probably not exceed £2,000 per annum. It may be stated that with a comparatively small increase on the capital expenditure above stated, provision might be made for the lighting of the Embankment Gardens and of Westminster and Waterloo bridges; but this is a matter which could afterwards be dealt with by the committees concerned. After full and careful consideration of the facts, and of estimates put before us by the council's officers, we have come to the conclusion that it is desirable that the electric light should be adopted as the illuminant for the Victoria Embankment, and that the council should itself undertake the work in connection therewith. We accordingly recommend that, subject to an estimate being submitted to the council by the Finance Committee as required by the statute, it be referred to the Highways Committee to carry out, at a cost not exceeding £10,000 an electric installation with the necessary plant for the lighting of the carriageway, footways, and parapet wall of the Victoria Embankment.

Notices under Electric Lighting Acts and Orders.

We have considered a notice, dated May 26th, 1892, from the London Electric Supply Corporation, of intention to lay distributing mains, in 4-inch cast-iron pipes, on each side of, and across, Deptford Bridge. We see no objection to what is proposed; and we therefore recommend that the sanction of the council be given to the works referred to in the notice, dated May 26th, 1892, of the London Electric Supply Corporation, upon condition that the Company do give two days' notice to the council's chief engineer before commencing the works, in the carrying out of which only one side of the bridge shall be obstructed at one time; that the mains be laid under the footways, and in such positions, and in such manner as the council's chief engineer may direct, and to his satisfaction; that the mains across the carriageway be also laid under his direction, and to his satisfaction; that no street boxes shall be constructed until the mode of construction of them shall have been submitted to and approved by the council's chief engineer; that all pipes or openings from or into the boxes shall be of such shape as to remove all risk or injury to the covering of the cables; that all cables crossing the boxes shall be supported from below in the boxes; that all service lines or small cables shall be protected, where leaving the boxes, by an extra lead covering or by wooden stoppers, and shall also have a copper wire of sufficient size carried from the service to the main cable, in good connection with the lead or iron outer casing, and that the ends of all mains terminating elsewhere than in a box shall be securely protected by iron caps, in addition to any other covering.

We have also considered two notices from the Kensington and Knightsbridge Electric Lighting Company; one dated May 28th, 1892, of intention to lay mains in Ennismore Gardens, and the other dated June 1st, 1892, of proposed extension of mains in Queen's Gate Place. The proposed works are of a satisfactory character; and we recommend that the sanction of the council be given to the works referred to in the two notices dated May 28th and June 1st, 1892, respectively, of the Kensington and Knightsbridge Electric Lighting Company.

The St. James and Pall Mall Electric Light Company has given a notice dated June 13th, 1892, of proposed works in Piccadilly, opposite Burlington House and opposite the vestry hall, and also at the corner of Pall Mall and St. James's Street. The works consist of the substitution of insulated and armoured cable for the existing bare copper mains at the points indicated in the notice and plans, and it is extremely desirable that this should be done as quickly as possible. We recommend that the sanction of the council be given to the works referred to in the notice dated June 13th, 1892, of the St. James and Pall Mall Electric Light Company.

We have also to report the receipt of the undermentioned notices, given in accordance with the resolution of the council to accept four days' (instead of one month's) notice in respect of the laying of service lines from mains already laid:—

From the House-to-House Electric Light Supply Company—June 2nd, 1892, to 9, Allen Terrace; 31, Courtfield Road; June 11th, 1892, to 12, Courtfield Gardens.

From the London Electric Supply Corporation—June 4th, 1892, to 14, Hobart Place; Union Bank, Southwark Street; Crosse and Blackwell's premises, Belvedere Road; 38, Deptford Broadway; June 10th, 1892, to 19, Southwark Street; 21, Tooley Street; June 16th, 1892, to St. Stephen's Club House, Westminster Bridge Road.

From the St. James and Pall Mall Electric Light Company—June 9th, 1892, to 89, Regent Street.

From the Electricity Supply Corporation—June 11th, 1892, to 26, Suffolk Street; June 14th, 1892, several houses on each side of the Strand.

London, Deptford and Greenwich Tramways Company—Use of Mechanical Power.

This company has made application for the consent of the council to experiments being made upon the company's lines with a motor worked by oil. The company's Act of 1889 authorises the Board of Trade to issue a license for the use of mechanical power, other than steam, upon the company's tramways, but provides that such license shall not be given until the consent of the local authority, *i.e.*, the council, and of the road authorities, shall have been obtained. The company states that the experiments will probably commence on June 28th and 29th, and will extend over a period not exceeding two months; and expresses its willingness to give to the council any information it may desire to have as to the experiments while they are being carried out. We see no reason for the council's consent being withheld; and we recommend that the consent of the council be given to the use by the London, Deptford and Greenwich Tramways Company of mechanical power, other than steam, upon its tramways during a period of two months from June 28th, 1892, such consent being subject to the provisions of Section 43 of the Southwark and

Deptford Tramways Act, 1889, and that the company and the Board of Trade be so informed.

The report of the Parliamentary Committee contained the following:—

Telegraphs Bill.

1. Our attention has been directed to a Bill, which has been introduced by the Postmaster-General at this late period of the Session, to authorise the Government to raise money with a view to carry into effect the scheme of the Postmaster-General for the development of that part of the telegraphic system of the United Kingdom which is called the telephonic system, and in particular with a view to purchase and provide the main lines of telephonic communication. By Clause 21 of the London Overhead Wires Act, 1891, it is provided that nothing in the Act or in the council's bye-laws shall extend to telegraphic lines belonging to or used by the Postmaster-General, and consequently the result of the passing of this Bill in its present shape would be that a large number of overhead wires which at present are, or shortly will be, subject to the council's bye-laws, would be exempted from the council's supervision.

There are other matters affecting the council which need careful consideration, such as it has been impossible to give by reason of the rapidity with which the Bill has been pressed forward. The Bill, which has been reported by the Select Committee, stands for consideration in Committee of the whole House on Friday, the 17th inst., and we have requested members of the council to oppose its further progress, unless some arrangement can be come to which will meet the above objections. We recommend that the course taken be approved.

LEGAL.

Denby v. Ernest Scott & Mountain.—In the Court of Session, Edinburgh, on Wednesday, the Second Division gave judgment in a reclaiming note by pursuer against the judgment of Lord Kyllachy, in the Outer House, in the action brought by John Denby, stereotyper and electrotyper, 4, Swinton Row, Edinburgh, against Ernest Scott & Mountain, engineers, Close Works, Newcastle. Pursuer sued for £500. Defenders, he said, who were then known by the name of Ernest Scott & Co., exhibited electrical manufactures in the Edinburgh Exhibition of last year, and he, on their assurance that they could supply him with a machine for electrotyping purposes, ordered one at the price of £55. The machine, he said, did not work satisfactorily, depositing the copper in granular form, and he claimed damages in respect that defenders had supplied him with a machine which was constructed for nickel-plating. Defenders said the machine which they supplied the pursuer was capable of doing the work pursuer intended it for, but that he did not fit it up properly, nor work it skilfully.

Lord KYLLACHY, in giving judgment in the Outer House, said he was not quite sure that, long as the proof had been, it had quite cleared up the mystery of this dynamo. He had, however, come to the conclusion that he must find for the defenders, on the ground that pursuer had not proved that the dynamo was disconform to contract. It was clear that the dynamo did not give satisfactory results; on the contrary, the results were hopelessly bad, and pursuer, after trying everything he knew, and everything which defenders suggested, was unable to effect any improvement. He could not say that defenders had succeeded in establishing any fault against pursuer's bath or his solution, or his manipulation of the bath. Difficult as the case was, he thought it was, however, on the whole, more probable that there was something wrong in the pursuer's management of his bath, or of his gas engine, than with the dynamo. He therefore granted absolvitor, with expenses.

The pursuer reclaimed to the Second Division, and asked leave to lead additional proof on a condescendence of *res noviter*, in which he averred that, since the proof, he had ascertained that certain tests were made of the machine in the defenders' works at Newcastle, before it was supplied to him, which would demonstrate that the machine was not suitable for electrotyping at the normal speed of his engine. The additional proof was led before Lord Rutherford Clark, on March 12th, when it was proved that the machine was now in Messrs. Chambers' works in Edinburgh, and on being tested, it gave exactly the same results as when tested at Newcastle, and further, that on being turned to electrotype work, the work it produced was first class.

The Second Division, on Wednesday, refused the reclaiming note, assoilzied the defenders, and found them entitled to further expenses.

Lord YOUNG, who gave the leading opinion, said it was much to be regretted, looking at the expense involved in the bringing of the action, that the pursuer had given an order for a machine before he knew how to work it. His Lordship was of opinion that if the pursuer intended to reject the machine as disconform to contract, it was not done timeously; but on the proof his Lordship said the evidence disclosed that the defenders had supplied the machine contracted for, and that it was perfectly suitable for electrotyping. The other judges concurred.

Counsel for the pursuer and reclaimer: Mr. Sym and Mr. McLennan. Agents: Gray & Kinmont, S.S.C.

Counsel for the defenders and respondents: Mr. Asher, Q.C., and Mr. Watt. Agent: David Hunter, S.S.C.

Atkinson v. Stephens, Smith & Co.—On Saturday last in the High Court, before the Lord Chief Justice and a special jury, Mr. Harold Atkinson, of Goole, Yorkshire, brought an action against Messrs. Stephens, Smith & Co., electrical marine engineers, of Cuba Street, Millwall, to obtain £200 for breach of a contract to teach him the business of an electrical engineer. The defence set forth that they were willing to teach the business to the plaintiff, but he refused to be taught, and habitually stayed away from the works. Mr. Thompson was for the plaintiff, Mr. Dickens, Q.C., and Mr. Tatlock were for the defendants.

Mr. THOMPSON, in opening the case, said that Mr. Atkinson, was apprenticed to the firm for three years, he paying a premium of £100, and in addition to learning electrical engineering, he was to be taught mechanical drawing, and to be given a knowledge of electric motors. He entered into the service of Messrs. Stephens, Smith & Co., in November, 1889. The first day he put in an appearance he was told to go into the drawing room. He went, but found nobody there. After some time, however, three other students entered. There was nothing for them to do, and when some time had elapsed, they went into the electrical engineering shop. There were only two men there, one filing brass and the other winding a dynamo. There was practically nothing for the students to do and nobody to teach them. This went on for some time, so that the plaintiff learned absolutely nothing. The orders for electrical engines were few and far between. There was a German gentleman who came once or twice a month to make experiments, and the students, if they thought well, could look on or assist him. Certainly that was not the way to teach a student electrical engineering in all its branches. In consequence of illness the plaintiff had to go on a voyage to Spain, and on returning he found only two men and four students in the electrical department. The plaintiff, however, studied at home, and attended the Finsbury Technical College, and in an examination of some hundreds of students, he came out in the third place; therefore, it could not be put forward that Mr. Atkinson was an idle apprentice, because he made a dynamo from his own design. The allegation that he wasted his time was absolutely unfounded. Mr. Atkinson made a complaint to his father, and an interview took place with Mr. Stephens. At very rare intervals the plaintiff received instruction in drawing.

The PLAINTIFF was called, and bore out the statement of counsel. He was afterwards examined at length by Mr. Dickens, to show that he carried away the firm's materials, and that he refused to be taught his profession. It was not true there were 25 men and boys employed in electrical engineering work, and that the total number of men employed there was 40. During nearly three years he was on the premises there was only one dynamo and about 12 motors. He admitted the firm made electrical machinery for a launch, but they did not fit out an electrical tramcar. Very few repairs were done to dynamos.

A witness named DAWSON, who was also a student with the defendants, gave general corroborative evidence to that of the plaintiff. Although a student to learn electrical engineering, he was employed for about three months in filing brass nuts. The two workmen in the electrical department were ordinary mechanics.

Mr. DICKENS, for the defendants, argued that Mr. Atkinson was asked to learn his business from the beginning, but he was above this, and refused to be taught. He took a high hand, and when asked to do work he refused, saying he was not going to be made a mechanic.

Mr. STEPHENS, one of the partners in the defendant firm, stated that the plaintiff refused to learn. When he was asked to wind a dynamo he refused, saying any fool of a labourer at 25s. a week could do that. Mr. Atkinson never made complaints about not being taught.

The court adjourned, and the case was continued on Monday, when Mr. STEPHENS was cross-examined. He said there were between 30 and 40 men engaged in the electrical department. He could not give the average wages. He was asked about the contracts the firm received, and if he could tell the difference between what was paid to his men for purely electrical work, and purely marine engineering work.

The LORD CHIEF JUSTICE: I don't often speak in this tone, but I say it is extremely unfair to ask such questions. You are making charges of fraud against this gentleman, and if you wanted to know what was in his books you ought to have given him notice.

Mr. THOMPSON: I want to show the amount of money paid for wages, and the amount of money probably received for contracts.

The LORD CHIEF JUSTICE: You bring an action to recover the premium paid by a man who, it is not denied, stopped away from his work, or used the materials of his employers in his own business. This gentleman says he wanted to teach Mr. Atkinson from the beginning, but he refused to be taught.

Mr. DICKENS: The plaintiff has had the discovery of our books.

The LORD CHIEF JUSTICE: If that is so, the plaintiff's side ought to have examined them, and come here prepared. The books before me are admirably kept.

Mr. THOMPSON: Oh, very well, my lord.

The LORD CHIEF JUSTICE: It is very ill. It is a very unfair way of attacking a man.

The WITNESS, in further cross-examination, said the plaintiff had the opportunity of learning the manufacture of dynamos, accumulators, electric switches, electric boats, tramways, and so on.

Mr. W. M. THOMAS, the draughtsman to the defendants' firm, said the plaintiff would not learn his business. He was always giving vent to stump oratory, and interfering with the other students by talking about progress and poverty.

A son of Mr. Stephens said that for several months the plaintiff only attended the works five hours a week, excluding holidays.

Evidence was next given that instead of two men being engaged in the electrical department, there were about 25.

After some legal arguments, the jury gave a verdict for the defendants, and judgment was entered accordingly.

Pink v. Electricity Supply Company for Spain, Limited.—Plaintiff in this action was engaged by defendants, under contract, as resident engineer in Madrid. Being unable to agree with the manager in Spain on technical matters of the highest importance, plaintiff, after a fruitless appeal to the directors in London, offered to resign, and was thereupon instantly dismissed by the said manager.

He returned to London under protest, and after waiting several weeks for an amicable settlement, commenced proceedings. The case was finally settled out of court by the defendants paying three months' salary in lieu of notice, first class travelling expenses, and all costs. Plaintiff has also received the following letter from the Electricity Supply Company for Spain, Limited: "I am directed by my Board to state with reference to the severance of your connection with the company, that during the period of your service, they feel assured you did your best to promote the interests of the company, and that the directors much regret that the termination of your agreement was unavoidable, owing entirely to a difference of opinion with the general manager of the company in Spain, due in a great measure to the want of a common language in which you could converse freely, and that the directors do not wish to be considered to impute any blame to you in the matter. They also wish to recognise at the same time the important economies effected by you in the working of the station. The directors will be happy to recommend you for the post of chief engineer to any similar undertaking.—(Signed) P. A. LATHAM, *Secretary*."

NEW PATENTS—1892.

10,715. "Improvements in conductors for the distribution of electrical energy." C. E. JACKSON. Dated June 7th. (*Complete.*)

10,716. "Improvements in and connected with junctions for electrical conductors." C. R. G. SMYTHE. Dated June 7th.

10,735. "An improved process and apparatus for making sodium, potassium, and like metals by electric action, and producing ferric chloride as a dry powder." H. C. BULL. Dated June 7th.

10,742. "Improvements in or relating to electric telegraphic signals-receiving apparatus." R. STEENBERG. Dated June 7th.

10,762. "Improvements in incandescent electric lamps." E. E. WEAVER and G. B. MANYPENNY. Dated June 7th. (*Complete.*)

10,777. "Improvements in electric batteries." THE PRINCESS COMPANY, LIMITED. (Communicated by The Princess Company, Limited, Mersch). Dated June 7th.

10,783. "Improvements in electro-pneumatic action for organs." T. CASSON. Dated June 7th.

10,818. "Improved electrical insulating conduit." C. BOLLE. (Communicated by C. W. Jefferson, United States.) Dated June 7th.

10,823. "Improvements in the construction and attachments of insulators for telegraph, telephone, and such like purposes." E. W. BULLER. Dated June 8th.

10,847. "An appliance for actuating an electric transformer switch." R. N. LUCAS, A. J. MAYNE and A. GEORGE. Dated June 8th.

10,850. "Improvements in primary voltaic batteries." H. WEYMERSCH. Dated June 8th. (*Complete.*)

10,855. "Improvements in secondary batteries." H. F. KIRKPATRICK-PICARD and H. THAME. Dated June 8th.

10,870. "Improvements in electrical measuring instruments." H. H. LAKE. (Communicated by E. Weston, United States). Dated June 8th. (*Complete.*)

10,873. "Improvements in electrical indicator apparatus." C. A. MCEVOY. Dated June 8th.

10,876. "Improvements in the reflection and distribution of the electric light." I. A. TIMMIS. Dated June 8th.

10,913. "Method for production of oxide of zinc." W. S. RAWSON and WOODHOUSE & RAWSON UNITED, LIMITED. Dated June 9th.

10,932. "Improvements in primary and secondary batteries for electric lighting and power." W. J. BIRNIE. Dated June 9th.

10,945. "An improved electrical advertising device." A. W. DAVIES and P. R. NUNES. Dated June 9th.

10,948. "Improvements in microphones." G. L. ANDERS and W. KOTTGEN. Dated June 10th.

10,999. "Improvements in electric clocks." A. B. WEBBER. Dated June 11th.

11,032. "An improvement in insulating supports for electrical conductors led in culverts." J. T. HARRIS. Dated June 11th.

11,038. "Improvements in electric signalling apparatus." G. BINSWANGER and H. J. COATES. Dated June 11th.

11,041. "Improvements in 'electrical safety devices.'" V. G. LIRONI. Dated June 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

The Price of all Specifications (old and new) is now 8d. each.

40. "Improvements in electricity meters." G. HOOKHAM. Dated January 1st. Relates to improvements in the meter described in Patent No. 4,225, 1887, and consists chiefly in wholly immersing the disc in mercury. 5 claims.

200. "Improvements in or connected with electric arc lamps." L. BRIANNE. Dated January 5th. The inventor employs a solenoid of fine wire mounted in derivation, the armature of which is mounted on a spindle integral with a rack or portion of a toothed pinion. This rack operates, by means of gearing, a toothed flywheel, the arbor of which supports the upper carbon holder. The armature, which is movable upon its horizontal spindle, by its weight causes the rack to gear with the flywheel and consequently raise the upper carbon holder, thereby producing the arc. In proportion as the carbons are consumed the arc, and with it its resistance, increasing, the solenoid acts and raises its armature up to the point where the last tooth of the rack becomes disengaged by the flywheel and by allowing its rotation under the weight of the upper carbon admits of its being fed, whereby the normal distance apart of the carbons is maintained, and the arc thus regulated. The carbon holders are adapted to clamp the carbons under the action of an eccentric. 2 claims.

258. "Improvements in electric arc lamps." A. GAY and R. HAMMOND. Dated January 6th. Has reference to a construction of electric arc lamps for alternating currents in which the position of one or both of the carbons is adjusted or controlled by an electric rotary motor of which the field magnet has compound winding, one of the windings being in the main circuit of the lamp, and the other in a shunt circuit around the arc, and the armature is encircled by a closed coil that can be moved in one direction partly around the armature by an electro-magnetic device arranged either in the main or in the shunt circuit, and in the opposite direction by a spring or its equivalent or two magnetic arrangements may be used for moving the closed coil, one being in the shunt circuit and arranged to rock the closed coil in one direction and the other being in the main circuit, and arranged to rock the coil in the other direction. 3 claims.

271. "Improvements connected with electric arc lamps." A. SCHOENERSTEDT. Dated January 6th. Claims:—1. In electric arc lamps, the arrangement of mechanism consisting of a frame turning upon an axis which is loaded at one end or drawn by a spring while at the same time an armature or a solenoid core moves the frame in the other direction as soon as the magnetic coil or the solenoid receives sufficient current. 2. In combination with the frame and with the axis thereof, a roller moving freely on such axis or a toothed wheel, whereby one or two carbons may be suspended by means of a cord or band or rack rods in such a manner that they drop together when the roller or rack rod is released. 3. A brake disc connected with the roller or the toothed wheel, or driven indirectly by suitable toothed or worm gearing, upon which a brake lever arranged to move on the frame *e*, or a brake spring comes to bear until the frame is moved by the armature, or by the solenoid core a sufficient distance for such brake lever or brake spring to strike upon a stop limiting the extent of its motion, whereby the brake disc is released. These contrivances having for their object to cause the frame to separate the carbons by means of the toothed gearing firmly held by the brake lever or spring while as soon as the magnetic coil or bobbin, or the solenoid receives sufficient current, the frame, and with it the brake lever or spring, is pulled out of its normal position until the said brake lever or spring is held by a fixed stop or limit, and is accordingly withdrawn from the brake disc, whereby the carbons are brought close together, and the arc light is regulated.

389. "Improvements in electricity meters." F. TEAGUE. Dated January 8th. Consists of a small motor actuated by current derived from the working circuit, and adapted (through the intervention of a train of wheels) to indicate the energy, in any desired units, by means of index fingers upon suitably marked dials. 7 claims.

617. "Improvements in the construction of electric arc lamps and appliances used therefor." H. J. ALLISON. (Communicated from abroad by B. B. Ward, of New York.) Dated January 13th. Consists, first, in an improved magnet system by which the carbons of the lamps are separated to form the arc, and are regulated in their feed; second, in the manner of disposing and mounting the artificial electric resistance used in connection with electric arc lamps; third, in improvements in the automatic safety appliances employed for protecting the lamp from injury in case the resistance of the circuit through the carbons should become abnormally high, or the arc should be ruptured. 8 claims.

5,043. "An improved apparatus for regulating the approach of the carbons in arc lamps." A. W. MONEY and H. NASH. Dated March 20th. Consists of two electro-magnets, one in series with the main circuit, the other a shunt across the arc, they being placed in suitable positions, and having loose cores, which are coupled together by means of rocking levers pivoted at their centre, the said centre being capable of moving vertically within certain limits. From these electro-magnets motion is imparted to a second pair of rocking levers connected together by cross bars, and which levers have for their pivot a spindle which carries a brake wheel and pinion, which pinion gears in a rack rod, to the bottom of which is attached the positive carbon. By raising the electro-magnet, the rocking levers are made to describe an arc; at the same time the lower levers, having the spindle carrying the brake wheel, &c., for their pivot, are made to move horizontally by a small inclined plane fixed to one of the lower levers and acting against a weighted adjustable roller, which causes two small rubber cushions carried by the cross bars, to press against the side of the said brake wheel and give it a slight turn, which separates the two carbon points. As the resistance of the arc increases, the two electro-magnets, which are wound differentially, control the length of the arc. 2 claims.

10,239. "Improvements in electrical block systems for railways.' A. H. R. GUILEY. Dated June 16th. The inventor makes one of the track rails a continuous conductor by connecting the rails electrically at the joints, and he divides the other rail into sections or blocks, and provides electrical connections therefor which overlap from one block to the other. He provides the road with contact pieces of peculiar construction, and arranges upon the locomotive a contact lever and alarm apparatus. 14 claims.

12,322. "Improvements in or relating to electrical welding." A. J. BOULT. (A communication from J. H. Bassler, of Pennsylvania.) Dated July 21st. Consists in first coating the meeting edges of the plates to be operated upon with carbon, then placing those edges

close together, then, by proper electrical conductors, sending simultaneously one current of electricity transversely through the joint from the upper surface of the plates, and another current transversely through the joint from the lower surface of the plates, and moving the plates in the direction of the seam with relation to the electrical conductors controlling the direction of said currents, in order that the line of joint may be subjected to the welding heat. 3 claims.

12,898. "Improvements in means to be employed in the electrical deposition of copper, and the obtainment of products from the operation." T. PARKER. Dated July 29th. Consists in arranging with the vessels a special vessel or special vessels, in which the area of the anode plates is reduced, so that to drive the thereby increased current across the reduced anode section in the special vessel or vessels, and taking the whole current used in the other vessels, a raised voltage is obtained, and by this increased voltage the aforesaid foreign metals are continously deposited from the solution giving an impure copper in the special vessel or vessels, and maintaining the solution in a normal condition. The whole solution is kept in continual circulation through the whole series of vessels, the current in the special vessel or vessels, as described, operating on the whole solution as it circulates through the series of vessels. The foreign metals are thus obtained combined with the copper in the special vessel or vessels, thus giving greatly lengthened activity to the solution, and enabling the deposition of copper to be continued at a much higher speed than has been hitherto practicable. 2 claims.

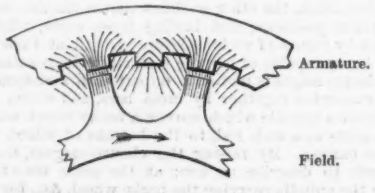
13,315. "Improvements in arc lamps." J. Y. JOHNSON. (Communicated from abroad by C. Bellens, of Paris.) Dated August 6th. Claims: 1. In a regulating mechanism for an arc lamp the combination of a rocking armature or lever plate acted on by a spring and carrying a train of gearing actuated by one of the carbon holders and locked by a catch or tooth, the movements of the said plate and of the gearing being controlled by an electro-magnet arranged in derivation upon the main circuit, so that the carbons are brought together and returned to their original distance in lighting the lamp, and are subsequently maintained at the required distance apart as they burn away, substantially as hereinbefore described and illustrated in the drawings. 2. The arrangements and combinations of parts constituting the improvements in arc lamps, substantially as described.

16,487. "Obtaining a fluid for primary batteries and utilising the waste products of such batteries." H. H. LEIGH. (Communicated from abroad by J. B. Gardiner, of New York.) Dated September 29th. Relates to a method or process whereby the inventor is enabled to obtain an efficient and comparatively cheap fluid for employment in the battery, and thereafter, in the further employment of the inventor's method or process, to recover the original substances employed in the process, together with the metal or the oxide of the metal which constitutes the electrode acted upon by the battery fluid. 22 claims.

CORRESPONDENCE.

Inductor Alternators.

In your issue of May 20th, 1892, in commenting on the above subject, you mention the fact that I have built several such machines—which is true. This is followed by the statement which, I believe, I have seen put forward before this, *i.e.*, "The heating of the field magnet cores must always be a source of trouble." Now, the fact is that at least in the machines of the type I have adopted, the "field



magnet cores" remain perfectly cool, giving no evidence of any production of heat in them. Nor should they, if the principle of their action is well understood. Furthermore, notwithstanding the fact that there has been very little ventilation of the part carrying the generating coils (which we may call the stationary armature), few machines show so little heat as these in their armature iron, and it is so low as to be almost negligible. Here again a proper idea of the theory of the action will involve the reason.

But a small fraction of the total armature iron undergoes any change of magnetism, and that only through a portion of a cycle. The magnetic lines only swing or change their direction in the iron, and a short distance back from the field poles can hardly shift at all. This will be understood from the figure.

Now in the ordinary alternator, all, or nearly all of the iron of the armature changes through a complete cycle, at each period. I have no doubt that in some types of poorly designed inductor alternators, the amount of material undergoing change of magnetism, and the extent of the change, may be as great, and perhaps greater than in ordinary alternator armatures, but my design was expressly made to avoid iron losses, and tests of its efficiency and temperature during running amply confirm the reasoning which led to the production of the type. It is also simple and substantial mechanically, which can hardly be said of several other types of inductor machines.

However, it is to be doubted whether these machines will replace the ordinary types, as we have found that greatly increased efficiency, much higher output, and very cool running, have followed upon a number of improvements in the latter. There has also resulted so substantial a mechanical construction as to leave little to be desired. The commercial efficiency is now considerably over 90 per cent., while the output has been increased 30 per cent. to 40 per cent., and the running temperature is greatly lowered.

These improved machines are greatly ahead of the inductor type of my design as to output, and the efficiency is nearly the same. I wish to say, however, that I have found the machines of the inductor type very satisfactory, except that they hum rather loudly, owing to the projections used, though not as loudly as other machines of ordinary type in use on the Continent.

For obtaining alternating currents of high periodicities, I have used my inductor design in preference. In fact, the first recorded results of the properties of such currents, up to a frequency of 4,000, were obtained from the use of such a machine, and the first recorded results of the comparatively low physiological effects of such currents was obtained by Dr. Edward Tatum, by using such a machine as the source.

The fact that a solid, well balanced iron mass, is all that is revolved, permits high speeds of revolution, and the fact that it may be serrated to give very numerous poles, makes the construction well adapted to high frequency machines.

Elihu Thomson.

Dynamo and Motor Design.

Referring to Mr. A. H. Gibson's inquiry, the "number of turns on surface of armature" means the total number of conductors on the periphery of the armature, and is applicable to either ring or drum windings. A complete explanation of the fundamental equation on which Mr. Bedell's curves are based is given in the fourth edition of "Dynamo-Electric Machinery."

A. T. Snell.

Thunderstorms and Electric Lighting.

On the evening of the 17th inst., at about 8 p.m., an entire branch circuit of incandescent lamps under my control went out simultaneously with an unusually vivid flash of lightning, followed almost instantaneously by a loud crash of thunder, having little or no roll, but being a single crack.

Upon examination, I found that no damage was done to lamps or mains, the branch fuse simply having gone. The mains are all laid underground in glass lined iron tubing, emerging from the ground at the point where the fuse in question is placed. So far as I have been able to ascertain, the tubing was not damaged in any way, which looks as if it had not been struck. That being so, I am at a loss to account for the sudden action of the fuse, and take the liberty of asking you whether it is feasible to account for it by attributing it to some effect of induction.

The building in which the lights are situated is more or less open all round, the roof being iron and well ventilated, owing to the heat of furnaces inside. Our system is of low (110 v.) pressure, direct current, the lamps being in parallel.

Robt. Jas. Elmhirst, *Electrician.*

June 21st, 1892.

[Probably some of our readers may have had a similar experience. The result would almost appear to have been due to causes recently pointed out by Mr. Preece.—EDS. ELEC. REV.]

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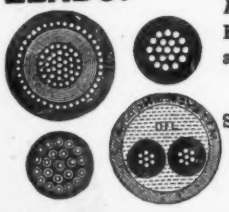

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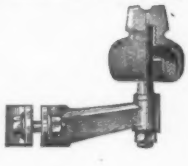

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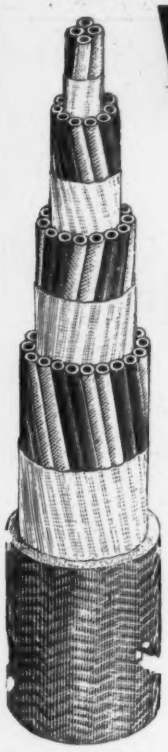

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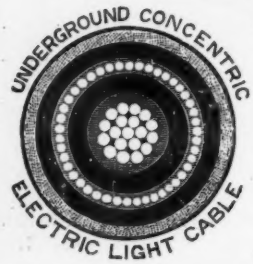

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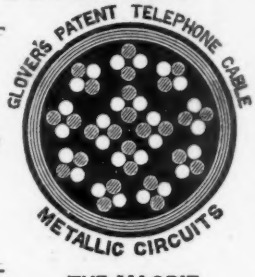

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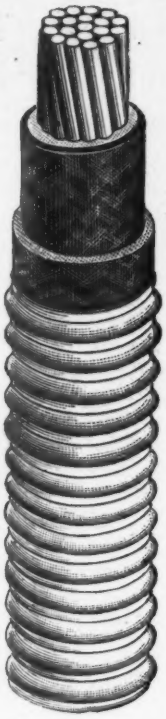

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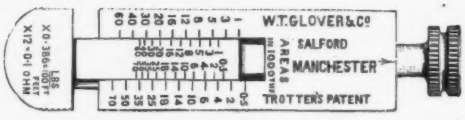

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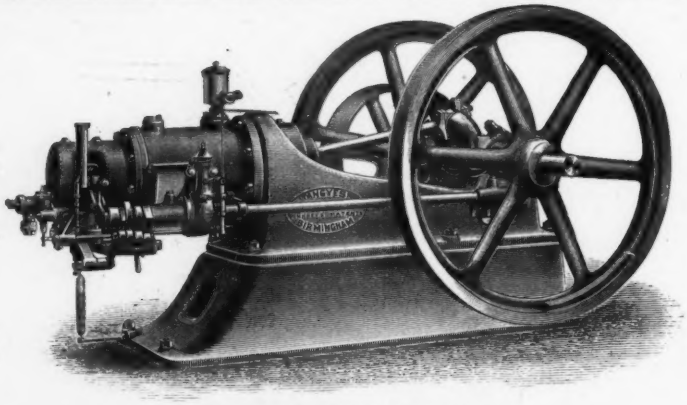

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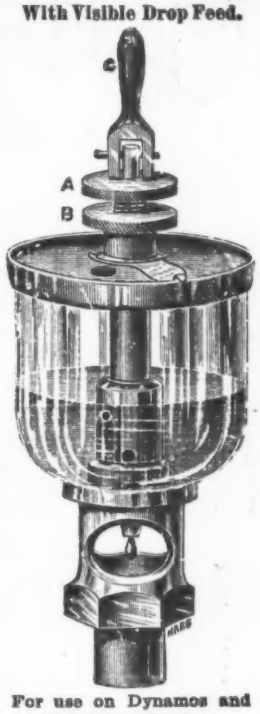

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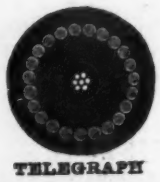

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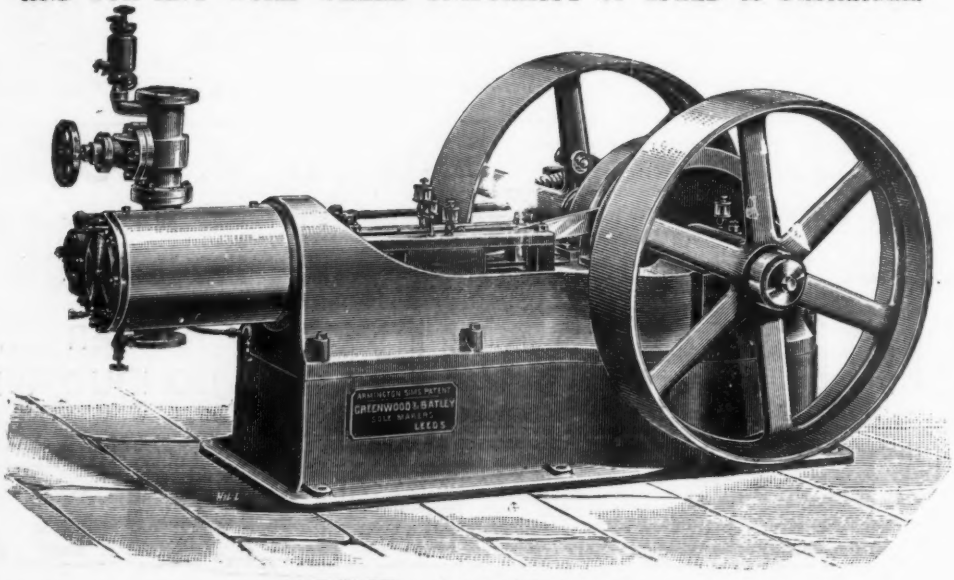

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Fig. 374.

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Fig. 379.

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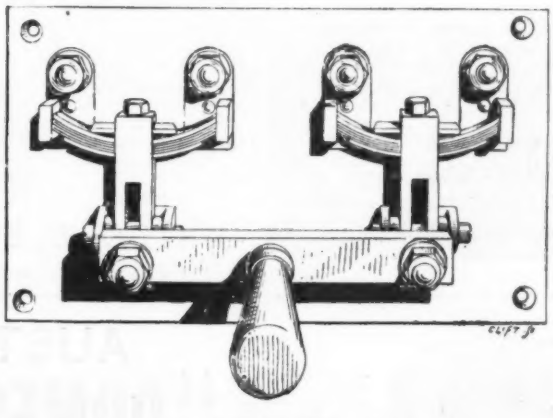

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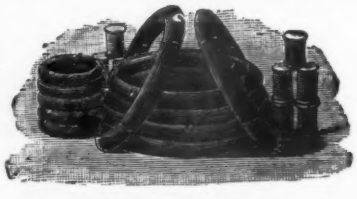

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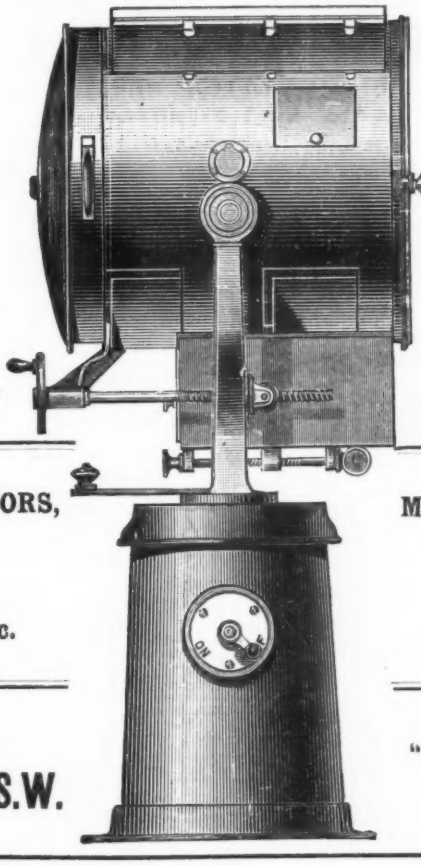

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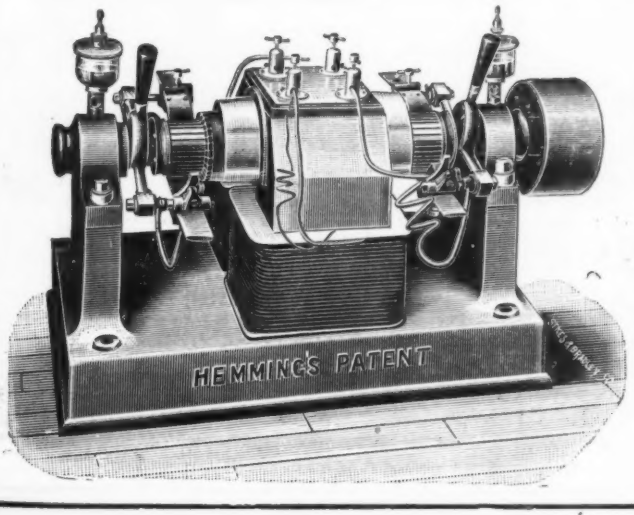

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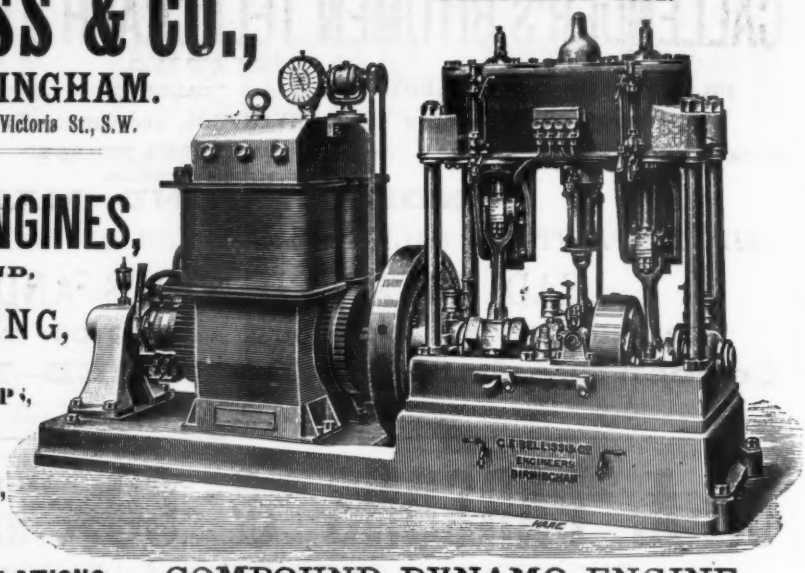

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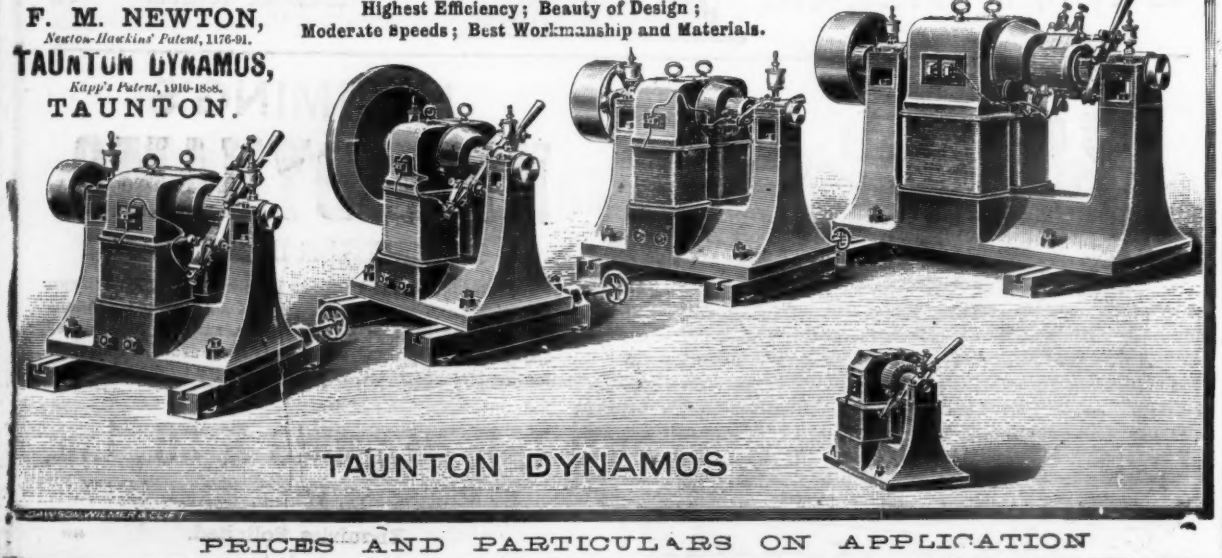

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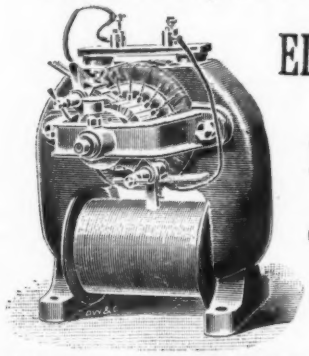

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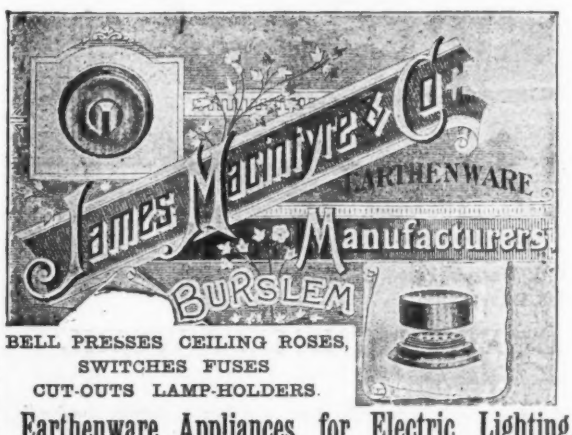

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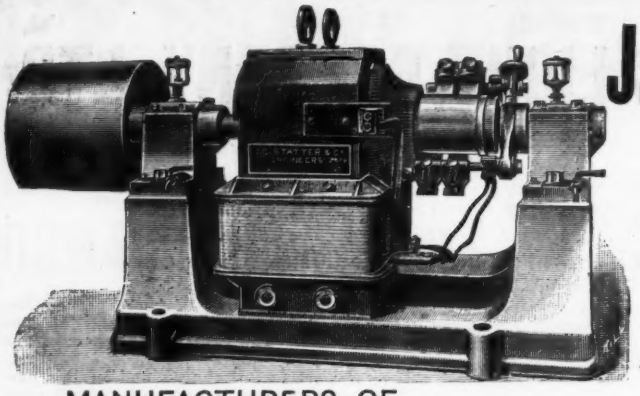

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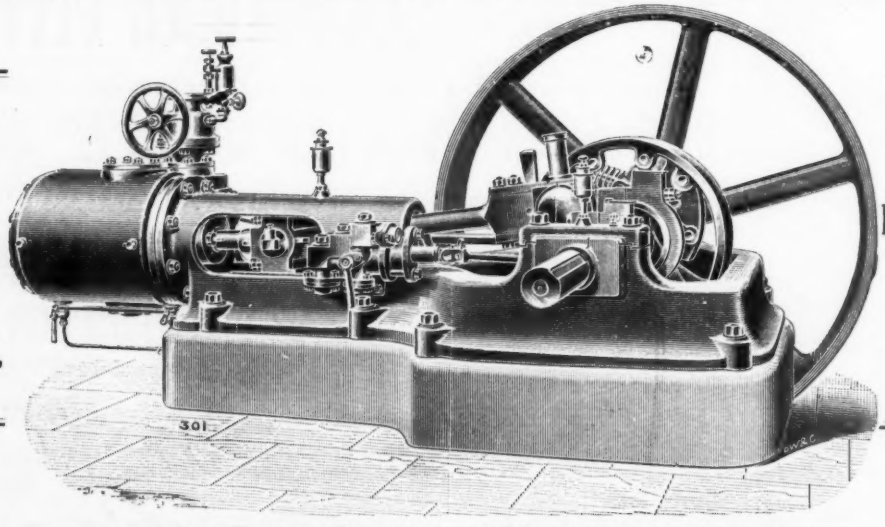

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Price, Sons & Co.... 11
Stiff & Sons ... ...
Telegraph Mfg. Co. ... *Sup.* 3
Woodhouse & Rawson United ... 15

Iron and Steel.—Turner Bros. ... 6

Lubricants.
G. Skudder & Co. 11
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Magnet Steel.—G. P. Wall ... 10

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International Electric Co. *Sup.* 1
Keys' Electric Co. ... *Sup.* 4
King, Mendham & Co. ... *Sup.* 10
Laurence, Scott & Co. ... ...
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James White 19
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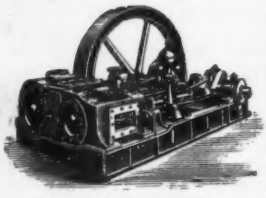

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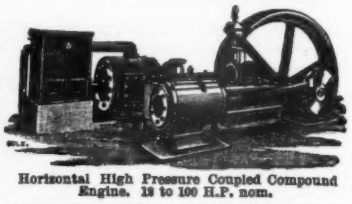

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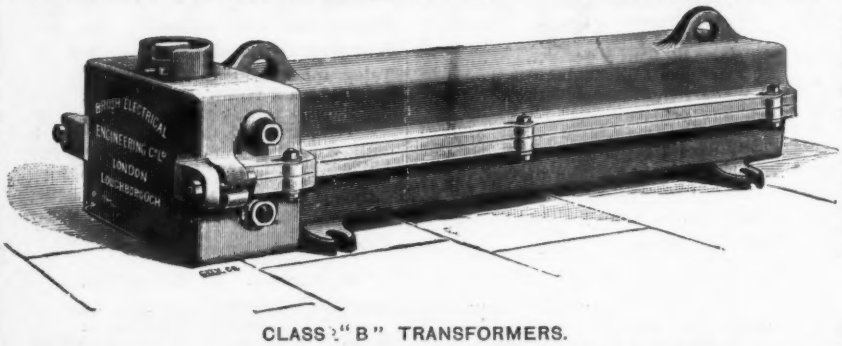

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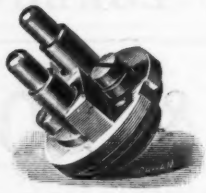

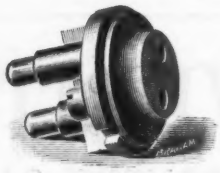

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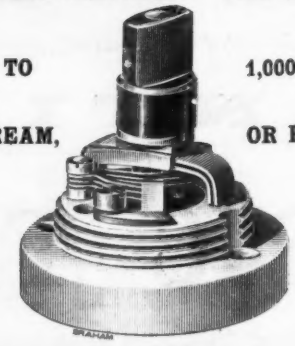

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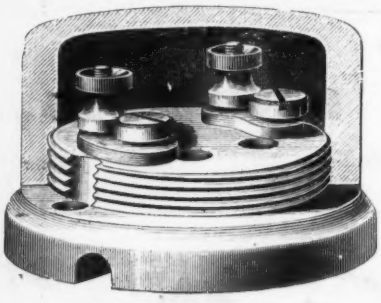

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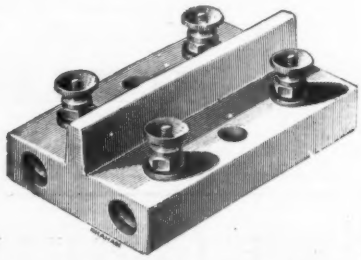

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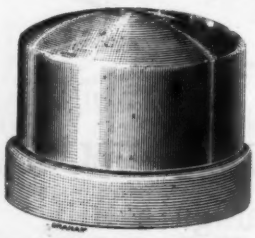

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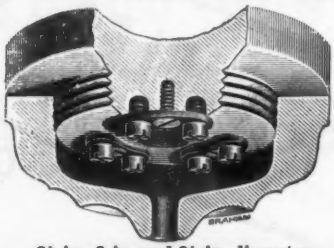

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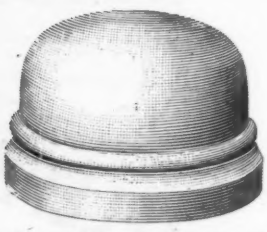

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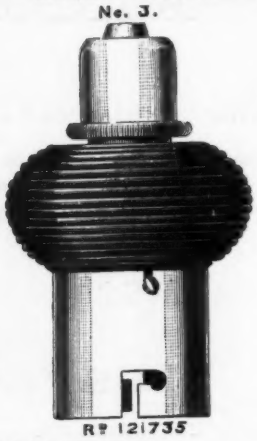

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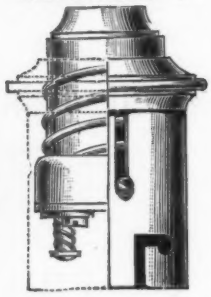

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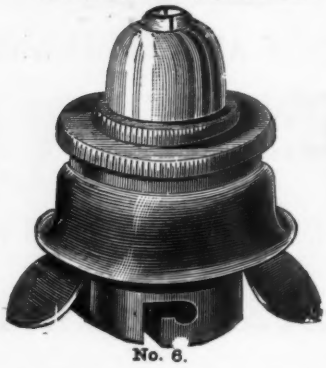

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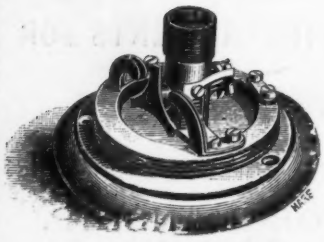

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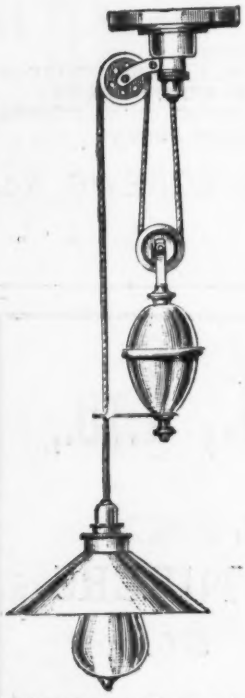

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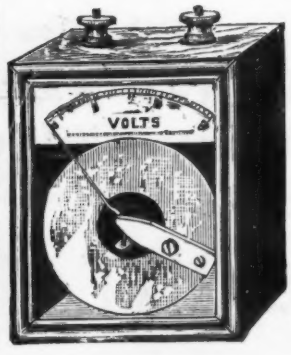

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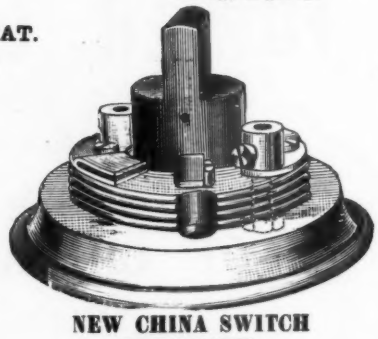

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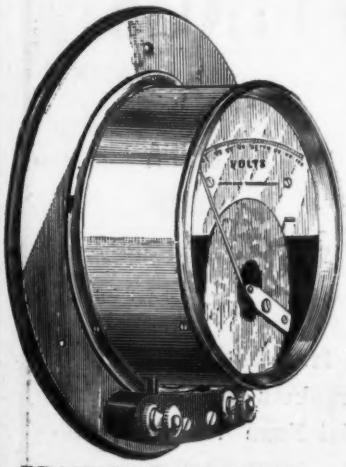

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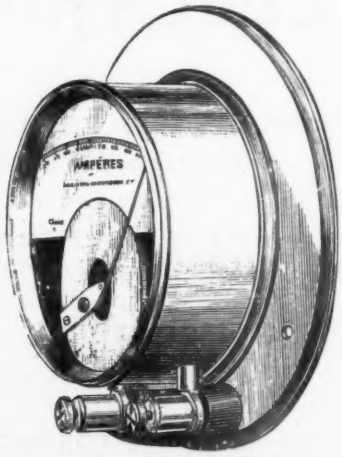

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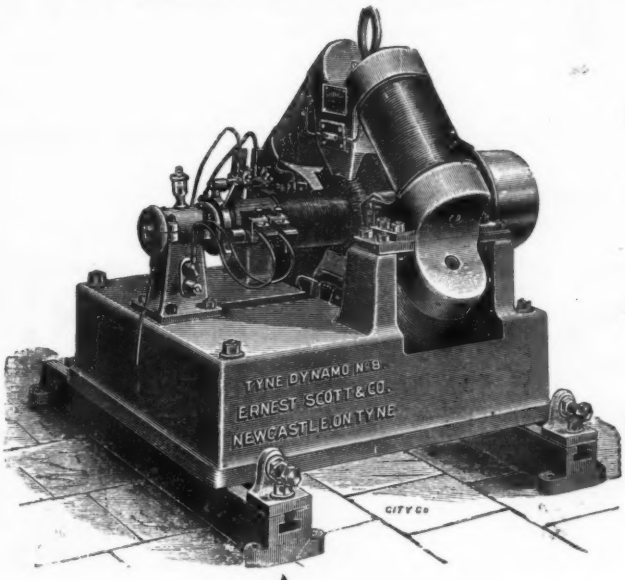

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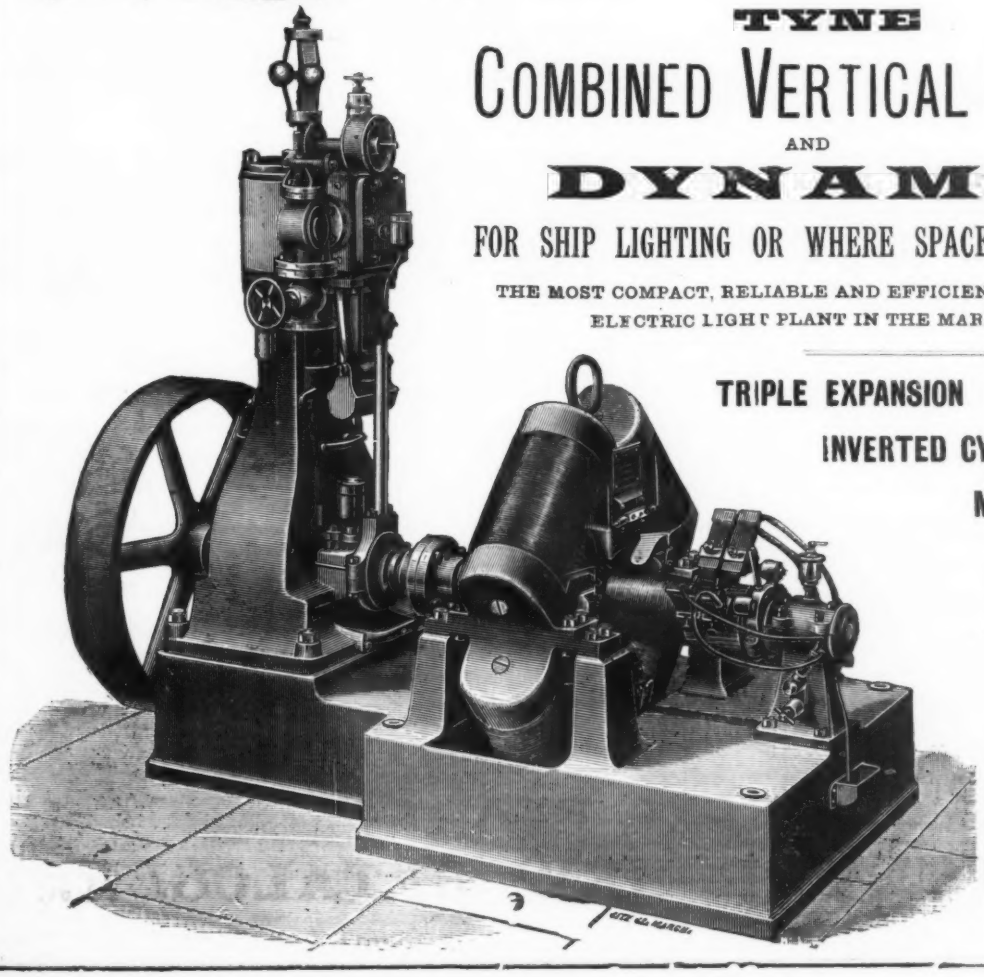

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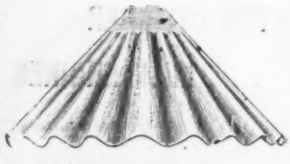

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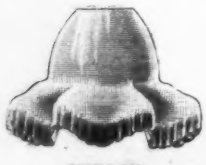

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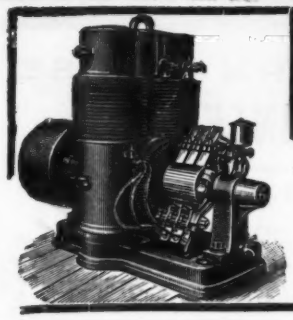

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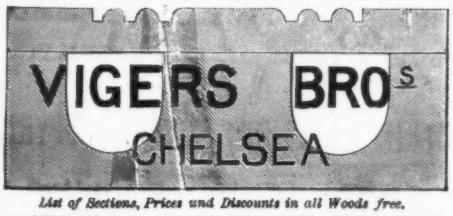

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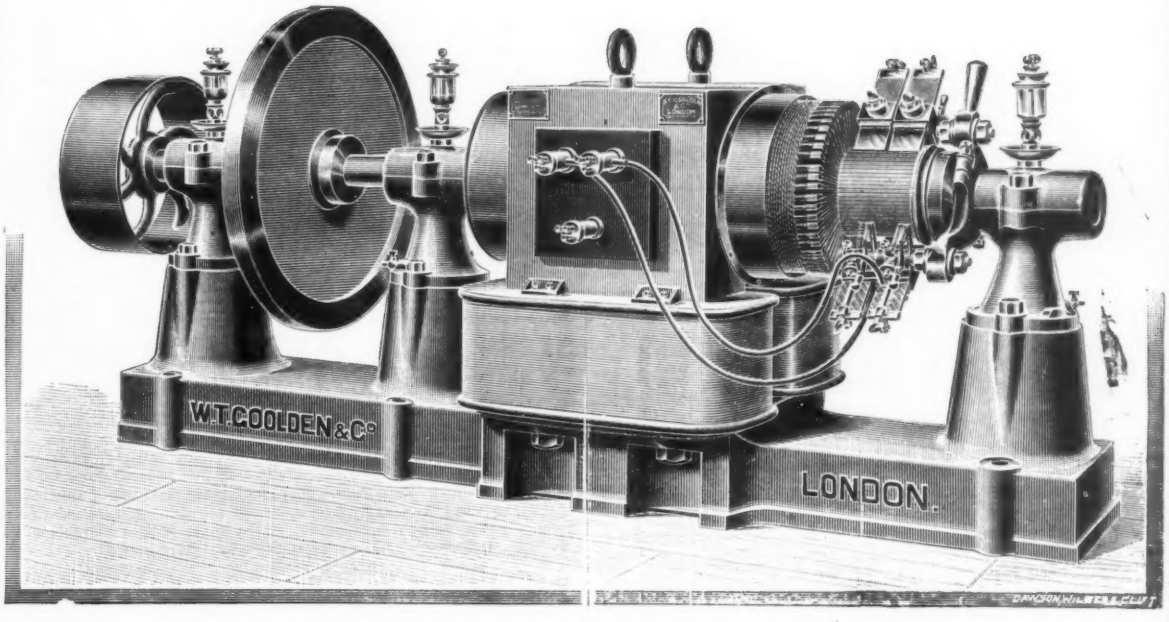

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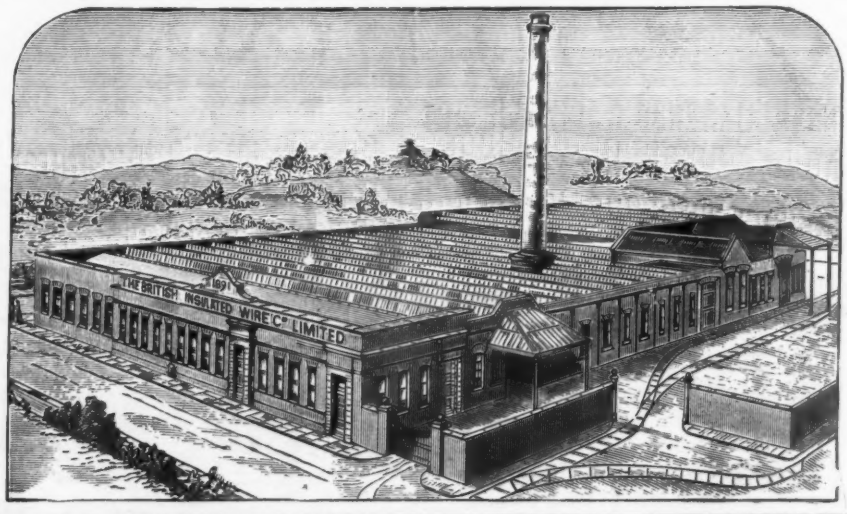

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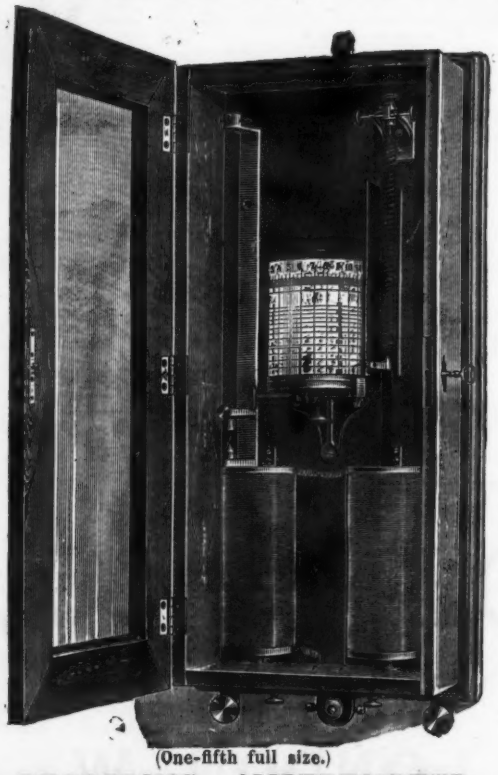

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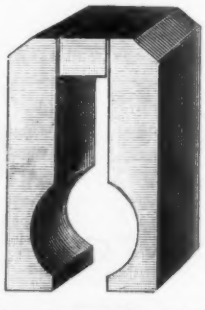

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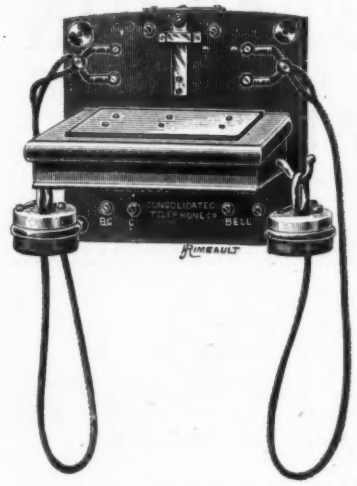

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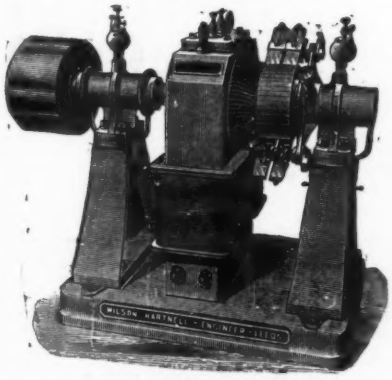

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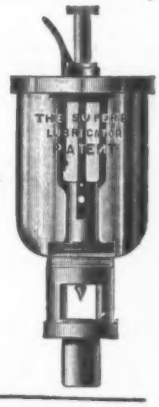

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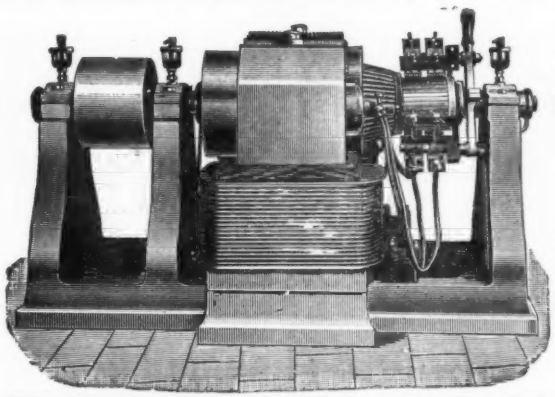

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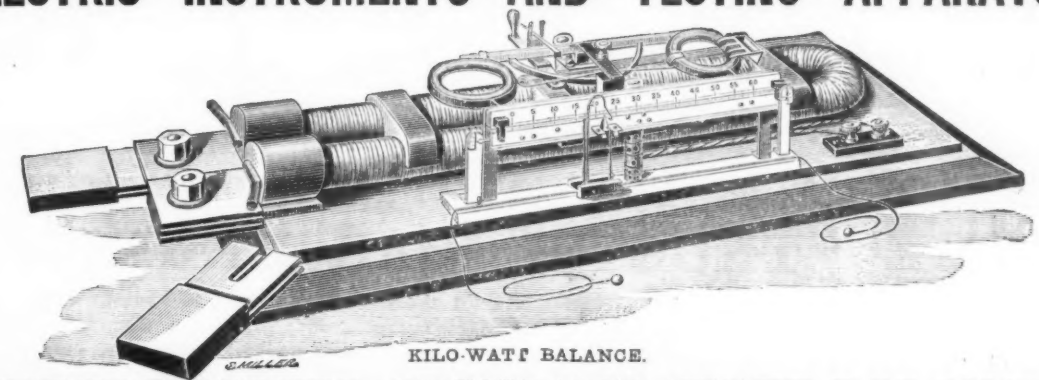

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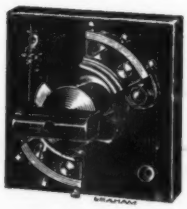

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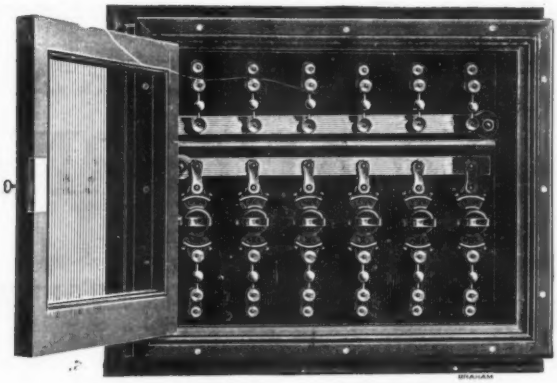

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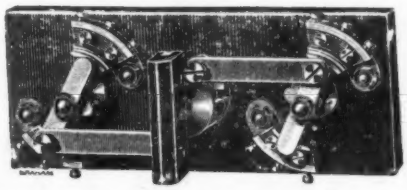

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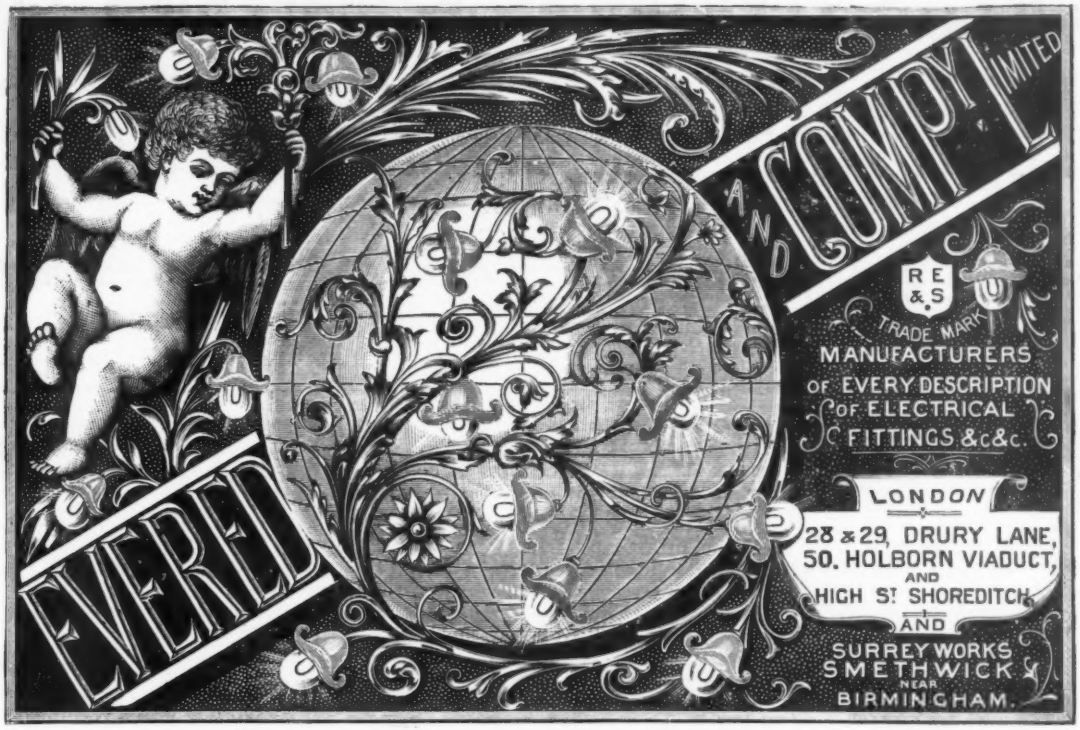

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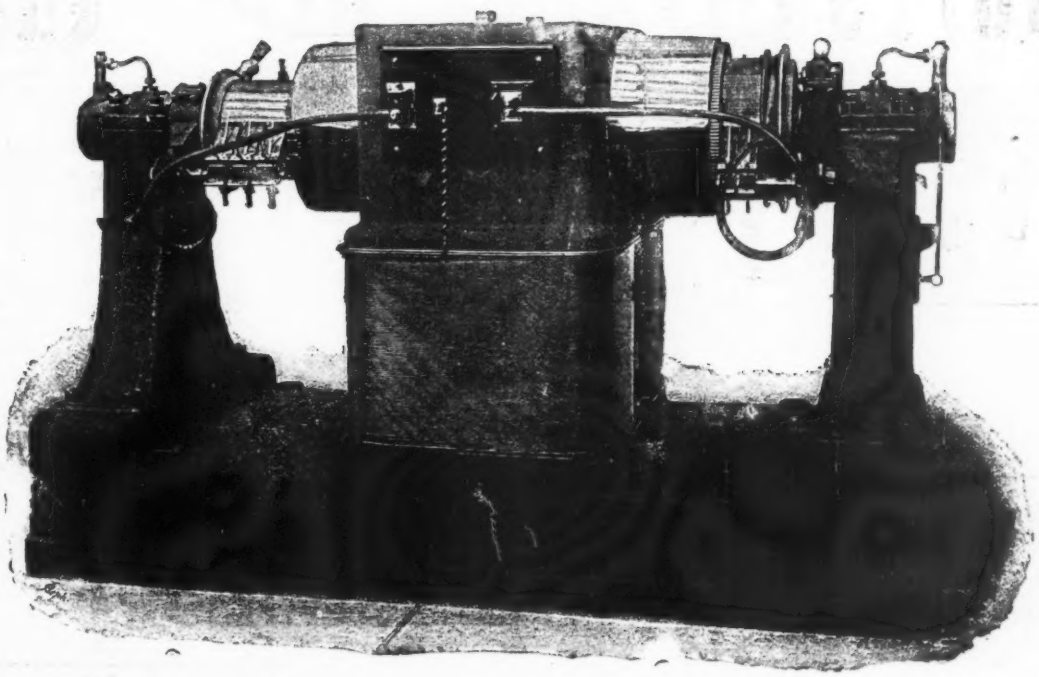

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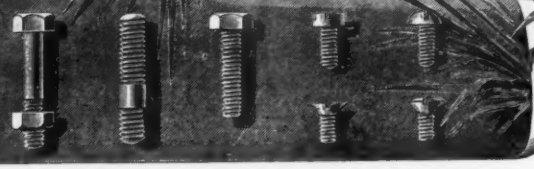

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ALL THESE GOODS ARE SHOWN IN FULL SIZE AND KEPT IN STOCK.

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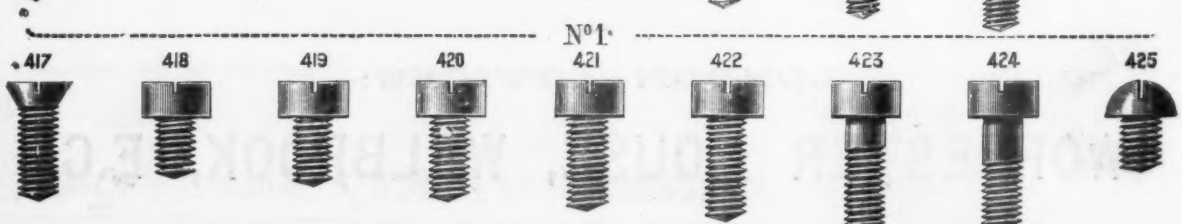

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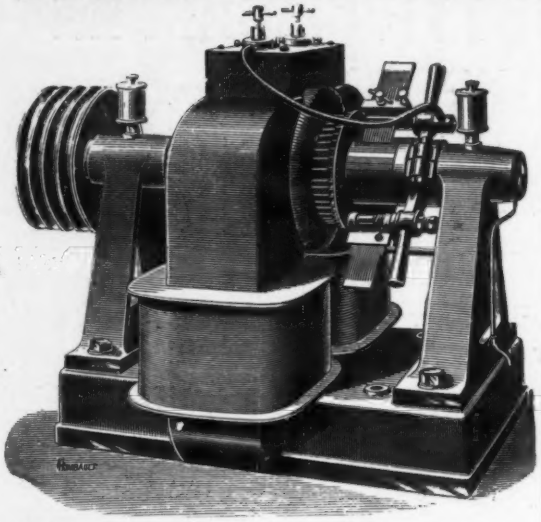
PHŒNIX DYNAMOS



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WRITE FOR PRICE LISTS 373

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"S" TYPE. MODERATE SPEED.

Size.	OUTPUT IN WATTS.	Difference of Potentials in Volts.	No. of 60 Watt Lamps.	Approx. Speed.	Approx. Horse Power.	PRICE.	Extra for Bedding Rails and Tightening Screws.	Extra for Fly Wheel for Gas Engine.
						£	£ s.	£ s.
1 S	600	30 to 60	10	1,800	1	20	1 10	2 0
2 S	900	40 to 70	15	1,750	1½	24	2 0	2 10
3 S	1,200	50 to 80	20	1,700	2	28	2 10	3 0
4 S	2,100	50 to 110	35	1,600	3½	38	3 0	3 10
5 S	3,000	60 to 110	50	1,520	5	44	3 5	4 0
6 S	4,500	60 to 110	75	1,430	7½	55	3 15	4 10
7 S	6,000	60 to 120	100	1,360	10	65	4 5	5 0
8 S	9,000	60 to 120	150	1,260	15	85	5 0	5 10
9 S	12,000	60 to 120	200	1,180	20	105	6 0	6 0
9½S	15,000	80 to 150	250	1,100	25	120	7 0	—
10 S	18,000	80 to 150	300	1,020	30	135	8 0	—
10½S	21,000	80 to 180	350	1,000	35	155	9 0	—
11 S	24,000	80 to 180	400	900	40	175	10 0	—
12 S	30,000	100 to 200	500	800	50	200	12 0	—

These prices refer to Compound, Series or Shunt Machines wound to a difference of potentials between the limits given. For those of higher or lower potentials, an additional charge will be made and special quotations submitted.

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For the same output, price 15 per cent. over above prices.

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"D" TYPE. SLOW SPEED.

Size.	OUTPUT IN WATTS.	Difference of Potentials in Volts.	No. of 60 Watt Lamps.	Approx Speed.	Approx. Horse Power.	PRICE.	Extra for Bedding Rails.
						£	£ s.
6D	9,000	65 to 110	150	750	15	110	6 0
7D	12,000	65 to 110	200	700	20	130	7 0
8D	18,000	65 to 110	300	650	30	170	8 0
9D	24,000	65 to 110	400	600	40	220	10 0
10D	36,000	110 to 125	600	500	60	290	12 0
11D	48,000	110 to 125	800	450	80	375	14 0
12D	60,000	110 to 125	1,000	400	100	450	16 0

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Small Announcements for middle pages Thursday 2 p.m.

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BIRMINGHAM	Corporation Street.	NEWCASTLE-ON-TYNE	6, Neville Street.
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